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A DATABASE DESIGN FOR THE MED POWER SUPPLY NETWORK

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[1] INTRODUCTION

During the 1981-82 summer vacation, I worked for the Christchurch Municipal Electricity Department (MED) developing and implementing a vehicle information system. During this period, Chris Axford, MED Staff Planning Engineer, first presented me with the problems involved in the design of a future MED Engineering Database.

The MED operates a complex electricity supply network about which it is necessary to maintain a vast quantity of technical information for operational, maintenance and planning purposes. Many small manual information systems in the forms of cards,maps, books etc. presently exist within the engineering divisions. These systems are often inaccessible and they lack co-ordination, flexibility and accuracy.

A well designed centralised computer database would not suffer from these limitations. Such a system would provide for any user a common pool of accurate and up to date information accessible on a straightforward and systematic basis. Engineering studies, statistical surveys and reports that are at present very hard to obtain could be produced with relative ease.

The problems and limitations of existing systems coupled with the obvious advantages of a centralised computer-based database makes a database system an obvious future requirement for the MED engineering divisions. The major database design difficulty lies in the development of a data structure to represent the network configuration. The complexity and vastness inherent in the design of the proposed database makes this design an ideal problem for an Honours Project.

The major aim of this project was to achieve the initial design step towards future database implementation. Progress towards this goal was aided by the interested supervision of Chris Axford and the guidance of Dr. Cooper.

[2] OUTLINE OF PROJECT OBJECTIVES AND DESIGN STEPS.

Overall objective: The formulation and testing of a database design upon which a future database implementation could be based.

This project is the first formal study of the described problem. It is intended to provide an initial design foundation from which further database development can proceed. Eventually efforts following this 'watershed' study will lead to a working database system.

Much early effort concentrated in the obtaining a complete understanding of the MED problem - its scope and terminology. This involved an informal study of MED operations and interviews with approximately 10 staff members.

Once this initial knowledge had been obtained a set of logical design steps was formulated:

(1) An analysis of existing information systems.

(2) The development of a model to represent physical equipment relationships.

(3a) Data analysis.

(3b) The construction of a 'conceptual' database model.

(4) Testing of the design via a demonstration database implementation.

Each of these steps is a clearly defined design task. These design 'building blocks' are sequenced in a logical practical order ,the successful completion of each step allowed work to proceed to the next design phase. The completion of each design step also meant the satisfying of a project objective. The four outlined design steps are documented in Chapters [4] to [7] of this project report.

Other project objectives which were not design steps:

(5) A suggested outline of steps towards future database implementation (Chapter 8).

(6) All progress made to be formally documented and the project to finish at a logical development stage.

[3] DEFINITION OF THE MED POWER SUPPLY NETWORK.

Before any discussion of database design details can begin, a brief description of the MED power supply network is necessary.

The Christchurch MED distributes electricity to its consumers via a complex supply network comprising some 2000 substations, 2000 km of underground cable and 1200 km of overhead line. A description of each of these three main network components is useful.

[3.1] Substations.

Concentrations of supply equipment are housed in substations situated throughout Christchurch. Installed equipment includes busbars, circuit breakers, isolating switches and transformers together with associated devices for operation, maintenance and protection.

Substations are the central focus of operational attention. Information concerning equipment is often stored using the substation location as a primary key. In addition to the equipment contained in substations, the MED maintains information concerning the land sites on which they are situated and building construction and maintenance details.

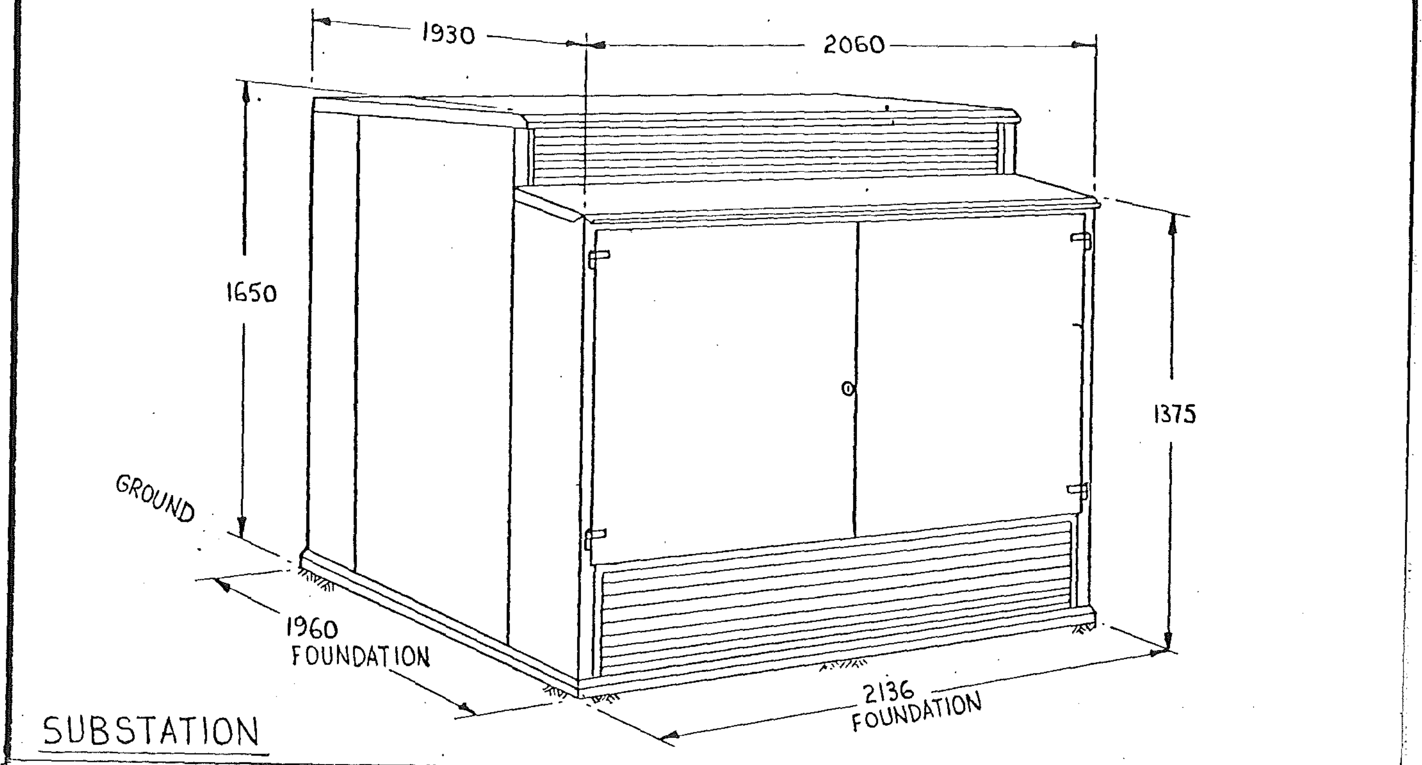
[3.1.1] Substation types.

There are various types of substations ranging from buildings (district and network substations) to small sheet steel kiosks and simple pole mounted transformers. A kiosk substation usually contains a few units of magnefix switchgear and a small transformer. District substations contain large 55-tonne transformers and approximately 30 circuit breakers plus a whole range of auxiliary, control, protection and communication equipment. Often a concentration of supply equipment is installed within an independent building such as a bank or school. This equipment concentration is also referred to as a substation.

Cables and lines running between substations link together the equipment they contain.

[3.2] Underground Cables.

For practical reasons cables are manufactured and laid in finite lengths, with 'thru' joints connecting individual lengths together. Sometimes three cable lengths are brought together at a common joint to provide a point of branching. The joint in this case is known as a 'tee' joint.



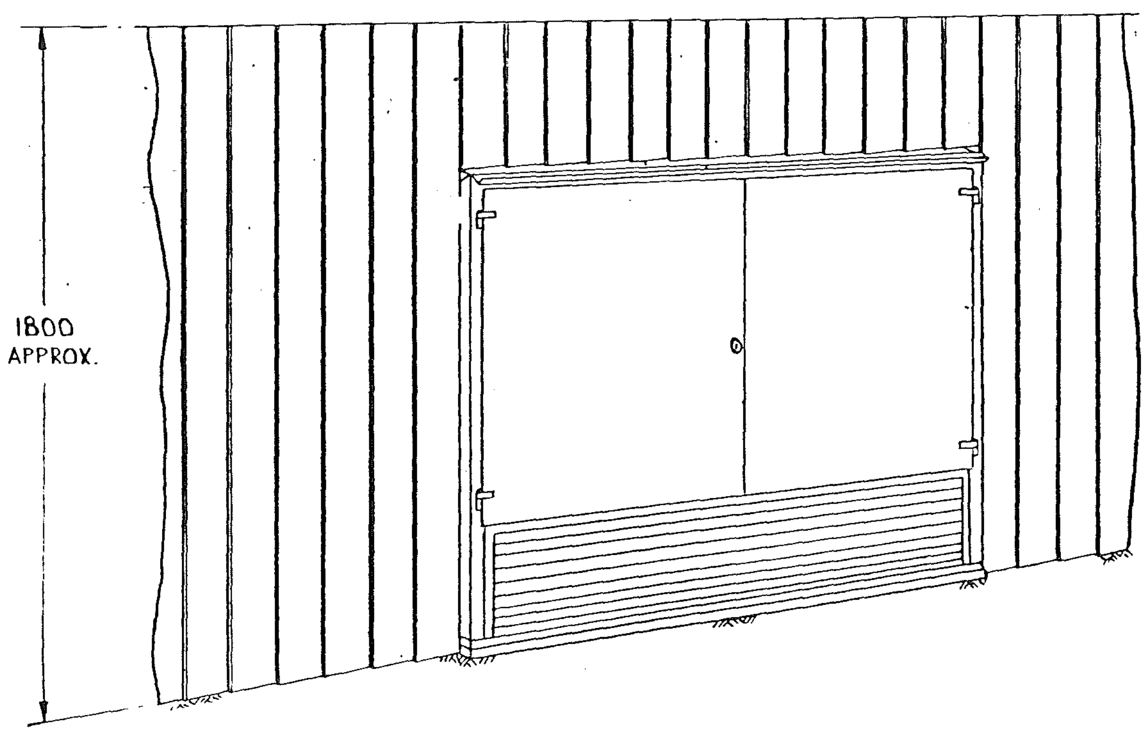
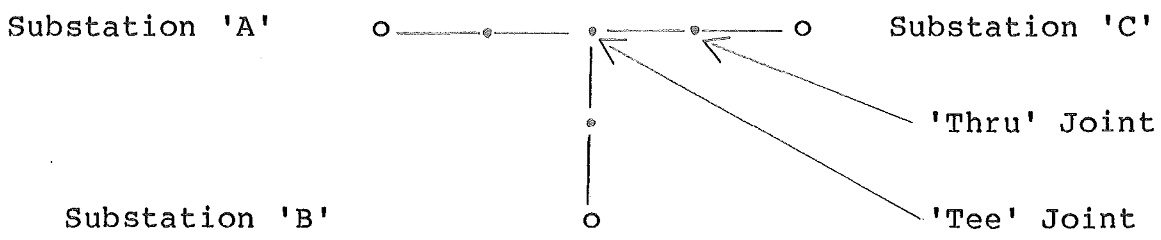


FIGURE (1) TWO EXAMPLES OF 'KIOSK' SUBSTATIONS

Pictonally:

Substation: o
Individual Cable length: ——
Cable Joint: ·



Thus an underground cable leaving a substation may, via a series of lengths and joints, provide an electrical connection to equipment housed in many other substations. There is a clear functional difference between the two types of cable joint, this distinction is important and is discussed further later.

The MED drawing office maintains detailed records concerning the lengths, sizes and types of cables laid as well as the position of 'tee' and 'thru' joints.

[3.3] Overhead Lines

High voltage (11 kV) lines are installed in the outer fringes of the urban area and low voltage lines (400 V) are still in common usage throughout the city. Their ready assessibility has led to the network configuration containing many links between lines;

complicated webs of linked lines are a feature of the supply network.

To enable portions of the network to be isolated for operational and maintenance reasons high voltage overhead lines are equipped with isolators, reclosers and sectionalisers. Isolators are operated manually and reclosers open automatically upon the detection of fault current and then attempt a set number of reclosures to deal with transient faults. Sectionalisers usually operate in conjunction with and 'downstream' of reclosers to isolate progressive segments of the network during a fault. These items of equipment are physically installed between two lengths of line.

Line: ——

Substation o————————————□————————

Recloser (or isolator, sectionaliser)

[3.4] Transformers.

The power coming into the MED supply network has a voltage of 66 000 volts (66 kV). This voltage is converted through network transformers eventually down to 400 volts. The underground cables that run down Christchurch streets and from which consumers tap power carry 400 volts.

The network which the proposed database will represent includes the routing of power from the incoming 66 kV feeders to the final transformation of power to 400V within local substations.

Transformers convert power initially from 66 kV to 11 kV. These large transformers are typically housed at district substations. 11kV power is routed to 'network' substations, which are usually only supplied power from one district substation. Provision is made for an alternative supplying district substation in emergency situations.

Network substations, inturn, route power to secondary, smaller substations ,usually kiosk or pole mounted substations. These low-level substations contain only a transformer which converts power from the incoming 11 kV to 400 volts, which is the voltage suitable for street supply. Physically linked to each transformer is a 'low voltage panel'. These panels divert power to different street destinations (low voltage circuits). The low voltage panel represents the outermost supply point at which the database inclusion of network equipment finishes.

[3.5] High Voltage Switchgear.

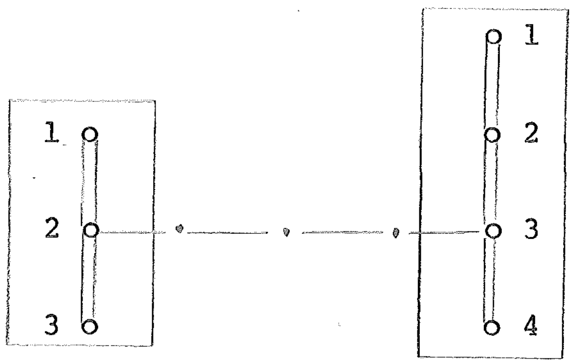
High voltage switchgear is a term used to denote equipment which is used to provide switching or a means of isolation at strategic points within the supply network. An isolator installed on an overhead line is is an example of a single unit of switchgear providing switching on a single circuit.

Single switching units may be installed together on to copper busbars to provide switching for a number of incoming and outgoing circuits. This configuration is used in district substations where rows of circuit breakers are commonly connected via a busbar.

[3.5.1] Circuit Breakers.

A circuit breaker is often connected to an underground cable and via a series of cable lengths and joins an electricial connection exists to another substation(s) from the circuit breaker.
Expressing this by a diagram:

Circuit breaker : o
Cable Length: ——
Cable Joint: ◦
Busbar: ═



Substation A Substation B

Circuit breaker 2 of substation A is connected to circuit breaker 3 of substation B. This electricial connection comprises four lengths of underground cable and three cable 'thru' joints. The above diagram represents a typical connection between a district substation and a network substation. Circuit breakers are also connected to overhead lines, transformers, all insulated units (description later) and other busbars.

[3.5.2] Switching Mechanism.

An incoming cable linked to a circuit breaker supplies power to a busbar. This power is diverted to different network destinations via busbar circuit breakers linked to outgoing circuits. Each circuit breaker provides a link to a concentration of network equipment. In turn, a row of these devices are linked together via a common busbar. Thus this configuration provides a mechanism for the routing of power throughout the network.

[3.5.3] High Voltage Switchgear Functions.

A circuit breaker will open, breaking an electricial circuit upon overload current or a fault. The most expensive switching device, it can be remotely operated.

Fuse switches, as the name suggests, are an electricial switch which contain a powder fuse. When a circuit overload or fault occurs the fuse blows, averting considerable damage to network equipment.

An oil switch does not have this tripping feature. It is simply an electricial switch enclosed in oil. The isolation of the switch in oil enables safer operation of the switch.

Circuit breakers, oil switches and fuse switches are functionally different devices but are configured similarly in the network.

[3.5.4] All Insulated Units.

Another major variety of high voltage switchgear are 'all insulated units' (AIUs). These modern devices are installed at almost every kiosk substation. An AIU contains several 'sub-units', bussed (or linked) together to provide isolation for a number of cable circuits and incorporate fuses when used to supply a transformer. A complete AIU is functionally similiar to a busbar with several connected circuit breakers. AIUs are known within the MED by the name 'Magnefix' (a major AIU brand name).

[3.6] Miscellaneous Equipment.

[3.6.1] Pilot Cables.

To provide communication links between different points on the network, 'pilot' cables have been laid. These pilot cables are used for communication purposes only, they are very different to the power cables described earlier. Wherever a reference to cables is made in this report the reference concerns power cables; all references to pilot cables are stated explicitly.

Pilot cables consist of several paired wires, and pilot cables are connected to pilot boxes within substations. Pilot cable circuits are installed for purposes such as telephone communication ,network monitoring and remote control, etc.

[3.6.2] Voltage and Auxiliary Transformers.

A voltage transformer is a metering device. Auxiliary transformers provide low voltage power for use within substations (heating, tripping equipment etc.) References to these types of transformers are explicitly stated, they are very different devices compared to the large supply transformers.

[3.6.3] Relays.

Relays are devices which perform network protection, monitoring and control functions. At district substations each circuit breaker has a relay associated with it.

[3.7] MED System Diagram.

Included as figure(1) is one page of the MED system diagram. This is prepared monthly by the MED drawing office. This page shows the network configuration for the Dallington area of Christchurch. More than twenty of such pages represent the entire network.

The diagram shows all substations in the area, all high voltage cables and all high voltage lines. Tee joints are shown but thru cable joints are not. The Dallington substation is a district substation, the only district substation in this area. The column of boxes which is Dallington represent individual circuit breakers. Gayhurst Rd. No. 152 and Hills Rd. No. 130 are examples of network substations. Hills Rd. No. 66 and Gayhurst Rd. No. 62 are examples of small kiosk substations.

FIGURE(1) THE SYSTEM DIAGRAM.

KEY

Underground Cable:

Overhead Line:

Transformer:

Tee Joint:

Isolator: G3

Recloser: R237

Kiosk (Transformer and Switchgear):

Kiosk (Switchgear only):

Pole Mounted Substation:

Building:

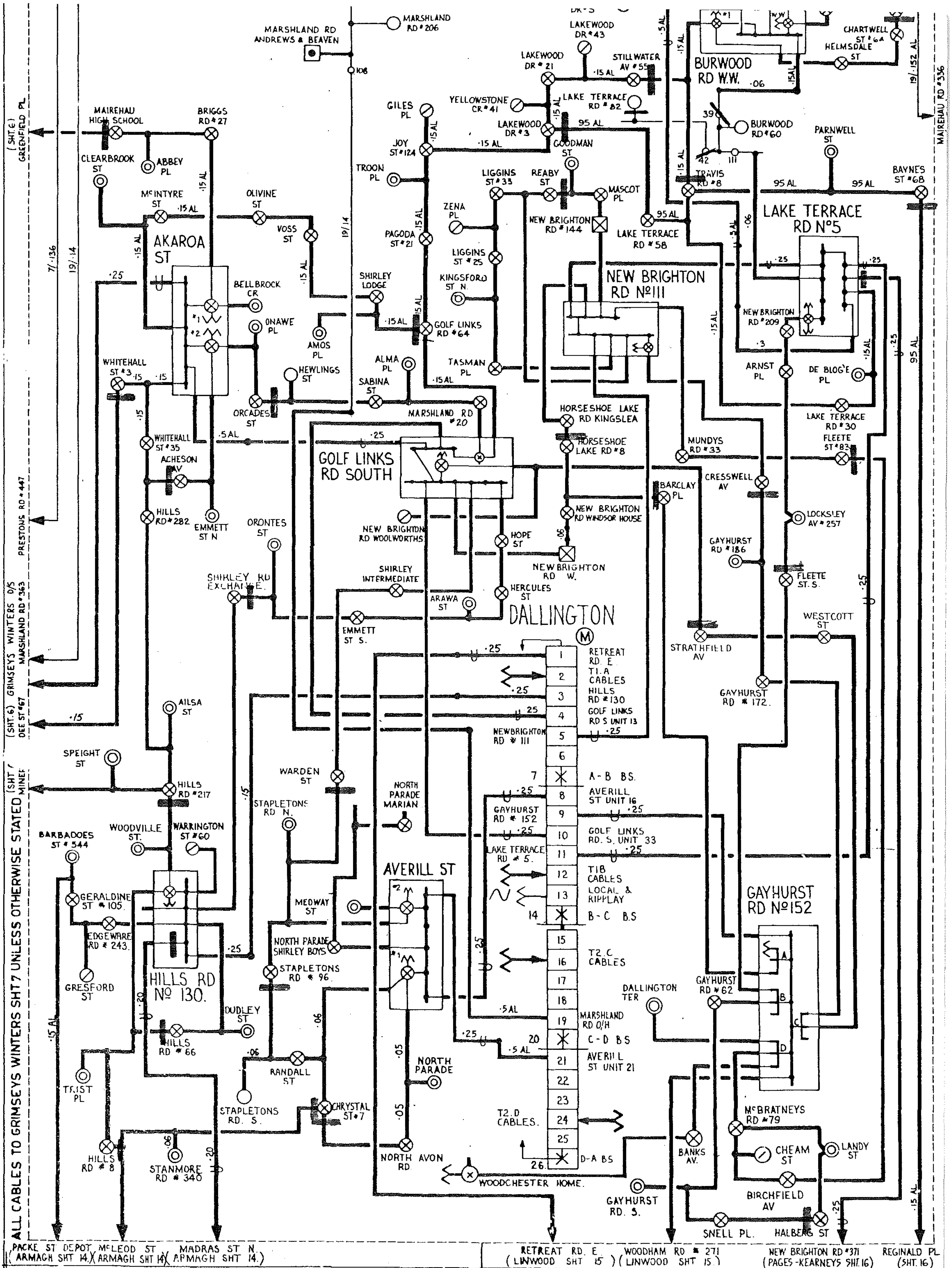
Building (Transformer and Switchgear):

Building (Switchgear only):

Busbar with CBs(or FSs, OSs):

CBs in District Substation: 12

Open Point:



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NOTES:
1. FOR FEEDERS SEE SHT 1.

DALLINGTON.

M.E.D. E 3005.

SHT 8

[4] ANALYSIS OF EXISTING SYSTEMS.

Numerous scattered information systems presently exist within the MED engineering divisions. Mostly manual in operation, the majority were developed many years ago and today rely on the knowledge of long-serving staff members. The initial design phase involved detailed examination of the existing systems. This analysis involved the collection of system documents, interviews with staff members and the observation of working systems. It was aimed at determining the function and information content of these systems.

The future database must replace the majority of the functions performed by the existing systems. It appears that some present system functions are only performed because of historical reasons. The examination of current systems for inclusion in the centralised database has exposed some archaic features which are no longer required. While some old system functions will not be continued ,some new functions will be included in the proposed database.

[4.1] Domain of Information Systems.

Information systems analysed came from the following MED areas:

Planning Division,
Substations Division,
Drawing Office.
Operations Division(Test Room and Control Room),

Mains Division.

The Planning Division has information systems centered on network transformers (computer), work instruction sheets (folders) and land sites (book). Initial interest for a future database has come from the Planning Division.

The majority of information in the future database will directly concern the Substations Division. This division maintains many card based systems recording information on network equipment: circuit breakers, oil switches, fuse switches, transformers, all insulated units, auxiliary transformers, low voltage panels and voltage transformers.

Further card based systems and also maps developed by the Drawing Office record cable, line, substation and isolator information. Using books and cards the Test Room keeps relay information and pilot cable data.

Rather than give exhaustive descriptions of all the systems analysed three typical systems have been chosen for a brief definition of their function and content.

[4.1.1] Substation Division Transformer Cards.

Each transformer owned by the MED, whether installed in the network or spare, has a Substation Division data card associated with it. Approximately 2000 cards are stored in a metal filing cabinet and they are sequenced by transformer make and serial number. Each transformer card has details such as make, serial number, price, purchase date, impedance, etc. This information is used for maintenance and accounting purposes.

Much information is duplicated. Transformers are usually purchased in groups, with all having similiar specifications. The design of this card system does not take advantage of this feature and common specifications are recorded for each individual transformer. The specifications are not recorded only once for the entire group but many times instead.

The problems with this and other card-based systems are illegible hand writing , loss of cards, difficulty in data maintenance, retention of redundant information (for example, a sold transformer may still have a card), and inflexibility. Card-based systems are inflexible in the sense that card formats are usually rigid and a data retrieval operation on a non-key item (such as transformer purchase date) is very tedious.

While MED card systems are today quite limited and antiquated they are most successful systems and have been used for many decades. It is only with the advent of new information technology, with all its benefits that has exposed the modern limitations of these old systems.

[4.1.2] Test Room Relays

The Test Room uses two card systems and a book system to record relay information. Each system stores relay data under a different primary key.

The book system has brief relay details sorted by

(a) relay type/function,

(b) make and

(c) purchase date.

For access the correct type is found followed by make and then finally purchase date. Sold and replaced relays have their entry crossed out. As more relays are purchased the book entries grow.

One card system is sequenced by the substation location of relays. The other card system, which uses colour coding, is sorted by relay make and relay type.

All three systems have been developed to enable efficient retrieval of relay information on several different keys.

[4.1.3] Planning Division Substations-Transformers file.

This was the only system analyzed which is computer-based. The system consists of a single random access disk file and a suite of FORTRAN programs, which interrogate the file.

Each existing network transformer has an associated record on the disk file, the file is accessed by substation name. Record fields contain data items such as system diagram grid references, substation type, transformer KVA and load statistics. Much of the stored information is also recorded by Substation Division card systems.

The Planning Division records transformer and substation information relevant for its function, data which it uses extensively in its activities. Only a subset of total transformer data is included in this system, the majority of the remaining transformer information is recorded by the Substations Division. Reports such as the winter load summary and listings such as substation 'rounds' are produced by the FORTRAN programs which access the data file.

All substations are visited at regular intervals for checking and the gathering of load statistics. A substation 'round' is a group of substations situated in a common area which are visited together sequentially.

The system file is updated monthly and then copies of the whole file are distributed to many staff members. A simple dump of the data file acts as a useful substation index for many activities revolving around substations.

This system is most successful, it is widely accepted and great use is made of it. However there is no data independence in this system between its data and the programs accessing it. Changes to data file formats lead to extensive changes to the set of accessing FORTRAN programs. The system has more flexibility than card systems but an exceptional query on a non-key item requires the writing of a FORTRAN program just for this special task.

[4.2] The formation of a Data Dictionary.

This first step in the database design was aimed at collecting as much information as possible about the MED systems, that is about the usage, relationships and meaning of stored data.

Gathered examples of present system documentation are listed in Appendix(I). Particularly relevant for close examination are the early documents(i...vii) ,those which belong to the systems discussed in this chapter. For the most part, the content of these documents is self-explanatory, however some of the engineering terminology is a little specialised. Before detailed design could formally begin definitions of all unknown data items and entities were obtained. This usually involved interviews with staff members. All data items names and definitions were gathered together to form a data dictionary.

[4.2.1] Data Dictionary Definition.

A 'data dictionary' contains sequenced information about data items, information such as name, orgin, description, format and usage. It is a database itself, it is 'data about data'.

[4.2.2] Data Dictionary Construction.

Data items in each report were identified and named, as were all items on cards, in books, on maps and in other filing schemes. Some of the items were discarded as a future requirement as they were deemed only a past requirement and no longer relevant. Conversely, new data items considered necessary in the future were added to the data dictionary.

To aid item identification and to group data items/elements in a logical manner, a naming convention was adopted. Items found on the same card or report, or belonging to the same equipment component were named with common leading characters. For example 'T_MAKE' (manufacturer) and 'T_OILVOL' (oil volume) are two items which belong to the aggregate of items concerning transformers. Names were limited to eight characters for reasons of brevity and compatibility with database management systems.

Most data items or elements appeared solely on one system document, but some items usually keys, appeared on various reports,cards etc. The leading example of this is 'L_MEDNAM' (MED name for a land site), this item is the key for land site information, information belonging to the substation on that site, and some information concerning the equipment within the substation.

The data dictionary is included as Appendix(II). For each data item its name, a description, an example, a format, and its orgin is listed. An example coupled with a description provides a clear definition of a data item.

The data dictionary is a useful reference tool, all data items named in the later phases of the design contain a definition in the data dictionary. Boundaries of the proposed system are effectively defined through the inclusion and exclusion of information items. It is important to note here, that all present information systems considered suitable for inclusion in the proposed database were analysed and their information content recorded in the data dictionary.

[5] DESIGN OF A MODEL REPRESENTING EQUIPMENT RELATIONSHIPS.

The design of the proposed database must represent the two inherent types of relationships that exist within the supply network.

(1) Inter-Entity Relationships.

The network contains numerous inter-related information entities. For example, a MED land site is usually associated with a substation and a substation is always associated with the equipment it houses.

(2) Physical Relationships.

The network contains complex physical relationships that exist between the individual pieces of supply equipment. These individual relationships are often simple instances of entity relationships, for example a low voltage panel is always physically connected to a transformer. However an underground cable can connect together a great variety of equipment components. The physical relationships involved in cable connections are not simple instances of a general relationship between entities.

Therefore a model is needed to represent these individual physical connections that are not simple cases of a consistent relationship between entities. Such a model is developed by this design phase. A logical approach is taken. There are two distinct sets of equipment which are configured differently in the network. A data structure representing their individual relationships is constructed.

The two distinct classes of equipment entities are:
(1) those which are installed in series, linking only two components, and
(2) those which provide network branching, linking together more than two components of equipment.

[5.1] Elements.

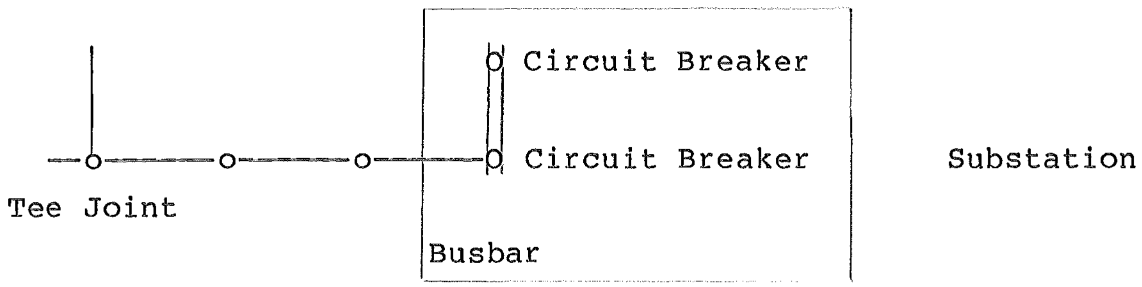
The term 'circuit element' is devised for equipment varieties which link together two supply points. Examples of circuit elements are lengths of cable, thru joints, lines, and circuit breakers. Each one of these entities is connected to two other entities, they have an incoming and outgoing connection.

Pictorially:

The length of cable is a circuit element as it connects only **two** items of equipment, the two thru joints.

[5.2] Nodes.

A 'network node' is an item of equipment installed between **more than two** other equipment items. Examples of nodes are busbars, tee joints, AIUs and low voltage panels. A tee joint links together three cable lengths, (three circuit elements). A node is a point of branching, it is where three or more elements are electrically linked. Via a series of circuit elements a node can have an electrical connection to other nodes.



The tee joint node is connected to the busbar node via 2 cable thru joints, 3 lengths of cable and a circuit breaker.

[5.3] Branches.

To represent the node relationships such as the one between the tee joint and the circuit breaker another concept is required. A sequence of elements linking two nodes is called a 'branch'. The tee joint and the busbar are connected through a branch, the tee joint 'branches' to the busbar and vice versa. A tee joint can have only three branches but a busbar can have many branches, depending on the number of circuit breakers linked to it, and the number of 'bus-sections' connecting it to other busbars.

[5.4] Relationships.

A branch consists of many circuit elements.
A node has one or more branches linking it to other nodes.
A branch links together two nodes.

Thus:

```
              1 : n
branch <-------->> elements

              1 : n
node   <--------->> branches

              1 : 2
branch <-------->> nodes
```

A substation can house several busbars, AIUs and low voltage panels. Thus it can contain many nodes, another relationship:

```
                 1 : n
substation <---->> nodes
```

This relationship of course does not hold for tee joints, they are usually situated outside substations.

Each line, cable, transformer, etc. is a circuit element, therefore a relationship exists between these equipment entities and elements. For example, a line is always a branch element, however a branch element is not always a line:

```
          restricted 1 : 1
     line ----------------> elements
```

Similarly each AIU, low voltage panel, etc. is a network node, for example:

```
          restricted 1 : 1
     AIU -----------------> nodes
```

[5.4.1] Node Identification.

Each node is uniquely identified through
 (1) substation location (substation name), and
 (2) its name.

This is nec~~c~~essary as names devised for network nodes are not unique between substations. The obvious name for a busbar node is the switchgear room in which it is installed. Many substations contain switchgear rooms known as 'Switchgear Room A'; this and other node names are not unique.

All tee joints belong to the 'artificial' substation 'Tee Joint', and their node name is a descripton of the substation sources of the three linked cable circuits. Using this description as part of tee joint identification aids navigation between branches and nodes.

Stored for each node is its type (busbar, tee joint, etc.) and its voltage.

[5.4.2] Branch Identification.

In order to record the sequence in which elements are configured between two linked nodes, each element is associated with a sequence number. One node is termed the top node and has an assumed sequence number of 0, and the other node is termed the bottom node, and has an assumed sequence number of infinity. Each element between the two nodes has a sequence number ranging from 1 to infinity. An element with sequence number 1 is linked to the top node and to the element with sequence number 2. The element with sequence number 3 is physically connected to elements with sequence numbers 2 and 4.

Deciding on which node is top or bottom does not really matter. A suggested convention is that the power supplying node be the top node and the power receiving node be the bottom node. For example, a branch between a district substation busbar and a network substation busbar has the district substation busbar as the top node.

The key for each branch is achieved through the specification of the two nodes it involves. The existence of two branches between nodes is not a possibility in this network.

Branch key:

(1) top substation name,
(2) top node name,
(3) bottom substation name,
(4) bottom node name.

[5.4.3] Element Identification.

Each circuit element is identified by the branch it belongs to and its sequence within that branch.

Element key:

(1) top substation name,
(2) top node name,
(3) bottom substation name,
(4) bottom node name,
(5) element sequence number.

Stored for each element is the element type (cable, line, etc.).

(The data analysis document (Appendix III) contains more details on the derivation of relations concerning elements, nodes, and branches.)

[6] DATA ANALYSIS

The final database design is expressed as a conceptual model. A conceptual model is an inherent model of information entities with the data items representing them, together with the relationships interconnecting the entities. It is based on the data processing needs of the database environment (in this case the MED).

By expressing the database design in such a way, the design is independent of the actual database management system chosen on which to implement the database. A conceptual model can be mapped to any data model, the three major data models being relational, network and hierarchical. Furthermore, a conceptual model is also independent of the hardware configuration chosen for the data model adopted.

To determine all entities and their inter-relationships all data elements contained within the data dictionary are analysed. This involves looking for which objects or concepts the elements belong to and which entity relationships the data elements are part of. Data analysis consists of the following steps.

[6.1] Identification of Information Entities.

An entity is a thing, place, event or concept about which information is recorded. The content of a database can be described by a listing of the entities it contains; a database contains information about one or more entities. In the design each different type of equipment is an information entity. Equipment entities include all the items described in chapter 3, components such as circuit breakers, transformers and relays etc. Other entities include work instruction sheets, land sites, substation rounds and the elements, nodes and branches outlined in the previous chapter. Usually the presence of a report or card containing information based on a common object (or concept) means this object is an information entity.

[6.2] Identification of Primary Keys.

Primary keys, or entity identifiers, are data elements which uniquely identify an information entity. For some entities the specification of a primary key is a relatively straightforward exercise, for example 'WIS_NO', work instruction sheet number is the obvious key for the WIS entity. However, most entities are uniquely identified through primary keys which consist of the combination of several data elements. For instance, the circuit breaker entity has a primary key which consists of land/substation name, node name and circuit breaker panel number - three elements form the primary key.

Often, a choice of primary key for an entity exists. Discussions with staff members will determine the most used data retrieval pathway and hence lead to the appropriate primary key being chosen. In certain cases allowances have to be made for an entity that needs two primary keys. This is necessary where there are two major data retrieval operations based on different primary keys. The solution to this problem is to create an 'index' relation between the two primary key candidates, with one key used as a unique identifier for the relation containing entity data.

[6.3] Determination of Inter-Entity relationships.

Through the examination of source documents, the observation of working systems and using accumulated knowledge of the database entities, the relationships between information entities are formally specified. This specification involves the determination of how equipment entities physically interface and how data items are grouped in reports.

This data analysis phase used the information gained from the interviews with staff which took place during the analysis of present systems. When this initial analysis was determining the contents of the data dictionary, a certain degree of data analysis was also concurrently being achieved. Using a naming convention to express data items in groups involved some data analysis, and the defining of data items often involved the specification of data relationships.

[6.4] Normalisation of Derived Relations.

The expression of a database design through the specification of all information entities and their inter-relationships allows useful concepts from the relational data model to be applied in the design process. The relational model uses a 'normalisation' concept to group data elements into tables which represent information entities and their inter-relationships. The normalisation theory is based on the observation that a certain set of relations (or tables) has better properties in an inserting, deleting and updating environment than do other sets of relations containing the same data. When the clearly defined set of normalisation steps are followed, developed relations are sure to work correctly in the data processing environment and will be fundamentally sound in structure.

The use of relational model concepts in this data analysis does not mean the relational approach must be followed in actual database implementation; relational model concepts or tools are only 'borrowed' to build a set of sound, correct relations.

[6.4.1] First Normal Form.

The first normalisation step involves the identification of primary keys, and the creation of initial relations with all non-key attributes having functional dependency on the primary keys. This 'first normal form' requires the mapping between primary key and non-key attributes to be one to one or one to many. A many to many relation is not in first normal form, a unique primary key needs to be defined. The data analysis document included as Appendix (III) has many examples of derived relations involving one to one, one to many and many to many mappings. This first normalisation step is similiar to the data analysis step outlined in section [6.3].

[6.4.2] Second Normal Form.

The second normalisation step redefines relations in which non-key data items or attributes have only partial dependence on the primary key for their unique identification. Partial dependence causes serious updating problems.

[6.4.3] Third Normal Form.

The third and final normalisation step used in the design involves the removal of transitive dependency between non-key data attributes within relations. The removal of this dependency is usually achieved through the specification of another relation containing the non-key attributes involved in the dependency. There are other higher levels of relational normalisation, the first three normalising steps are considered the most suitable and applicable for this database design.

[6.4.4] Derived Relations.

All derived relations are in third normal form. Most initially observed relations are already in third normal form, but in some cases relations have to be transformed to the third normal form standard.

The data analysis details involved in the specification of all information entities and relations is formally documented in Appendix(III). This document includes many examples of the normalisation of relations to third normal form. Over fifty relations are initially devised, but after the removal of duplicate relations and the combination of relations with identical primary keys the number is finally reduced to 38.

The database design includes 38 relations and over 200 individual data items, these two statistics reflect the size of this database problem.

[6.5] The Conceptual Model.

A graphical representation is used to present the final conceptual model. Relations are shown as boxes and the relationships between the primary keys of entities are shown as arrows. Unfortunately the model is to big fit on one sheet of paper and is spread on to eight pages (Appendix IV).

The conceptual model is based on a series of relation levels.

Relations with only one key data element are placed at level one, which is generally at the top of the graphical diagrams. Relations with primary keys consisting of the combination of two data items are placed at level two, lower on the diagrams and relations with keys consisting of three keys lower still, etc. Artificial level one relations are created where the data items which compose keys of level two, level three ... relations do not exist as level one entities. This is to show the participation of these data items in the composite keys of the higher level relations.

It is well known that a picture can communicate much better than words. The use of diagrams in expressing the developed relations is a good clear way of representing information entities and their inter-relationships. The pictorial representation is easier to study and to comprehend than a simple list of relations.

[7] DATABASE IMPLEMENTATION

[7.1] Purpose of the Implementation.

Perhaps the best test of any database design is actual database implementation and extensive use. A full scale implementation of the database was outside the bounds of this project. However a limited implementation was made. The implementation was intended to

(1) stand as a demonstration of the design in practice, and
(2) enable the testing of the various design features.

[7.2] Implementation Method.

[7.2.1] Data Model Chosen.

A physical database based on the relational approach was built from the conceptual model. Mapping to the relational data model was a relatively simple exercise, mapping to hierarchical or network models would have required some conversion of many of the developed relations.

[7.2.2] Database Management System Chosen.

The system was implemented on the MIMER database management system, installed on the Burroughs 6900. MIMER is a relational database system with a very powerful query command language facility. This MIMER-QL facility was extensively used in the development of the physical database and it provided a easy medium for testing the design. MIMER is a very 'user friendly' piece of software, and this together with its relational basis, makes it a system suitable for use by a wide range of people in many database environments, with database expertise not being an essential user requirement.

[7.2.3] Relations Mapped.

For the reason of brevity, only one half of the developed relations were mapped to MIMER. The relations implemented were considered the most important and those included are denoted in the list of final third normal form relations (Appendix(III)). Each relation corresponded to a MIMER relational table, 19 tables represented 19 relations. Two additional tables were constructed for the data dictionary and a table index. Within each implemented relation only critical (usually key) data elements were included. All data items which represent arrows in the conceptual model were part of the physical database. Despite having chosen to implement only a subset of all devised relations and within these relations only a fraction of all data items, the final database was nevertheless quite large, containing approximately 120 entity attributes.

[7.2.4] Network Area Implemented.

A small subset of the total supply network was selected to provide data for the relational tables. The chosen area centered on the Dallington District Substation, a description of which is included as figure (3). The area includes examples of all information entities. Not all items of equipment were included in the database. Only single examples of oil and fuse switches were included as they are configured similarly to circuit breakers and over 30 circuit breakers were described in the database. For simplicity, tee joints were numbered for unique identification, and only several cable thru joints were represented. The majority of the entered data was factually correct, although for some trivial items of information fictitious but realistic entries were made. Despite being only a small subset of the entire network this area represented about 300 table rows.The size of the 'MED' MIMER databank was approximately 100 000 characters.

[7.2.5] Query Program.

Once the MIMER tables were defined and loaded, database operations were executed to test the soundness of the design. A data retrieval 'program' was written through the use of MIMER

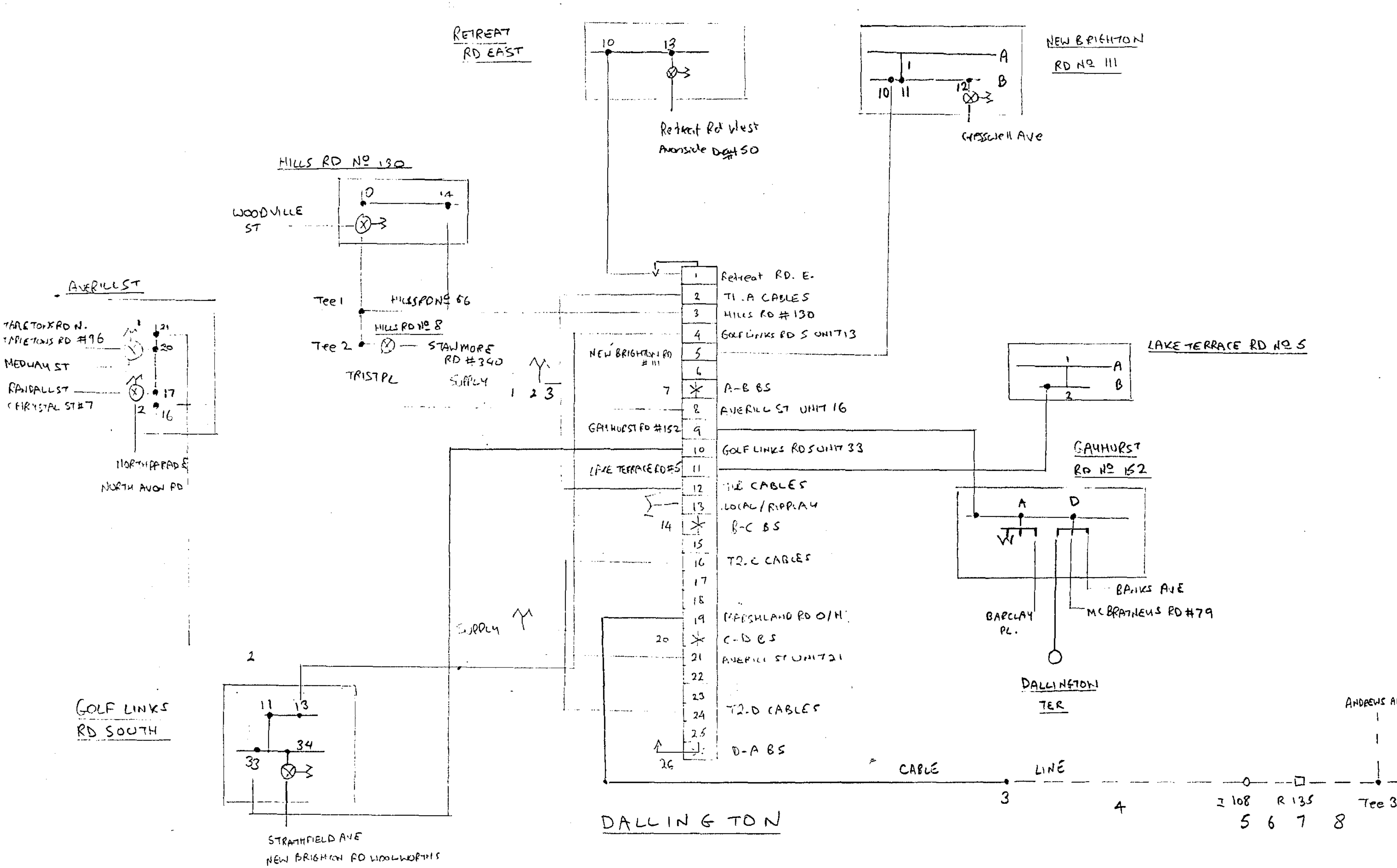


FIGURE (3)

THE NETWORK SUBSET IMPLEMENTED

procedures. It served as an interface between an inquiring user and the database. It answered over 30 queries on different entity keys. Use of this program effectively tested the designed data retrieval/insertion pathways and without a sound database design some queries could not have been implemented.

[7.3] Design Strengths and Weaknesses.

[7.3.1] MED Appraisal.

The design was informally examined by MED staff members but a formal appraisal from all interested parties has yet to be made. This coupled with the implementation not being extensively tested by MED users means the design has not been fully evaluated by the future database users. However, design features studied closely by MED staff were considered satisfactory.

[7.3.2] Strengths.

As mentioned above, major data retrieval operations were successfully executed, proving the database design sound. The developed relations were logically based on physical relationships and therefore a knowledge of the physical network configuration helps the comprehension of the purpose behind each MIMER table. However, the design assumed this user knowledge and to a layman the database implementation was not easy to understand. This is not a problem, as all present information systems upon which function the design was based, were used by people with knowledge of the network configuration.

Despite the initial intention that the implementation should be small, the relational tables infact contained a considerable amount of data. This confirms impressions held right through this design project - the proposed database will be large. Estimated database size, using the implementation size as a guide, will be the order of around 100 megabytes. This estimate is based on the fact that one thirtieth of the network was implemented, one third of all entities in the chosen subset were included ,one half of all relations were mapped and one fifth of all relation attributes were mapped. This is only a very approximate estimate, a more exact calculation is a future requirement.

[7.3.3] Criticisms.

Attributable in a small way to the amount of recorded data was the nodes-branches-elements model. The inclusion of full branch details for each branch element led to a large amount of repetitous data being recorded. A more concise method of branch identification is not really practical. Each branch could be associated with a unique 'branch number', and outside of the branch relation itself a branch could be recorded by number rather than top substation, top node ...etc. Despite being invisible to users this would increase design complexity.

Furthermore the creation of data item just for indexing purposes introduces redundancy and some retrieval/insertion operations would then involve two relations instead of one.

It is important in designs of this nature to avoid adding unnecessary new concepts foreign to the database environment. New concepts can confuse existing system users. The nodes-branches-elements model was introduced to represent physical relationships. It is a concept unfamiliar to MED staff. An equivalent model did not exist in the systems analysed, and with data on different equipment items becoming centralised and integrated such a model was necessary.

Database management systems maintain internal indices for the access of data sets. The more data items that compose an entity key, the greater the index overhead. Most relations had keys composed of several data items, thus much index overhead. But the keys derived were the keys necessary, they could not be redefined just for the reason of efficiency.

The one to two relation between branches and nodes will cause a problem if the conceptual model is mapped to the CODASYL (network) data model. In CODASYL sets a 'child' can only belong to one given set occurrence. Thus if a branch is to belong to two nodes a clash will occur unless the two ends are distinguished, or an indirect method of linkage is used. This problem, which can be overcome, is a result of the choice of data models that the conceptual model offers on which to implement the database. This independence of the conceptual model is a very desirable design feature.

The final implementation result was pleasing, it showed the design at work and gave it some practical credibility. Testing of the design was carried out by its designer. The implementation was not given extensive use by different MED staff members, this would have been the best design test.

Included as Appendix(V) is a one page listing of the relational tables which form the MIMER databank 'MED'. For each table a definition and a list of contents is given. Appendix (VI) contains the library of MIMER procedures which together form the data retrieval program.

[8] THE FUTURE OF THE DATABASE.

[8.1] Design Appraisal

This design project was intended to provide an initial foundation from which further database development could continue. The next step towards a future working system must the evaluation of the design by the different users of present MED systems. While staff members have informally appraised aspects of the design, what is needed is a thorough examination of this document by all concerned people and a formal evaluation. Coupled with this must be further demonstration of the implementation to a wider circle of MED users. Likely to require minor detail changes is the data dictionary, where some formats might need alteration and new items added.

This design appraisal or evaluation step will not be a simple exercise, it will require some staff education of elementary database concepts (primary key, data item etc.) before any 'user end' judgement can be made. Design modification is a cyclic process, initial design is followed by evaluation which is followed by further re-design and further evaluation - a continual loop. Even in an actual implementation database modifications are an ongoing occurrence.

[8.2] Size of the Database.

A useful statistic to have when looking ahead to full database implementation is an estimate of the size of the proposed system. Such a calculation is now possible, however it does not simply involve the addition of relation data attribute lengths (in bytes) and multiplication by the estimated number of rows. Consideration has to be made for future network growth , the data involved in the maintenance of internal indices and also the possibility of data coding where data items have only a limited set of possible values. Nevertheless, an estimate of database size is something that can be achieved in the near future, along with design evaluation.

[8.3] Future Hardware/Software Requirements.

Decision steps will need to be taken to devise what software and hardware configuration the new database will involve. A database management package such as MIMER provides database flexibility, has data and machine independence and offers many powerful facilities to database users and managers. Two clear database software alternatives exist: a system based on a package like MIMER or IMAGE (Hewlett-Packard), or a suite of application programs tailormade for the different data processing functions. Both alternatives have strong advantages and disadvantages.

There are also various alternatives possible for the hardware configuration. Perhaps an existing computer could be used or a new dedicated machine purchased. Compatibility between hardware and software is another consideration.

[9] LIST OF REFERENCES

Of considerable value for this project was:

'DATABASE - structured techniques for design performance and management.'
S. Atre, Wiley 1980.

Useful additional texts were:

'An Introduction to Database Systems.' (3rd edition)
C. Date, Addison-Wesley 1981.

and

'Fundamentals of Database Systems.'
S. Deen, Macmillan 1977.

During database implementation the MIMER/QL manual was an essential aid.

APPENDIX (I)

Examples of present system documentation.

(i) Substation division transformer card.

(ii) Testroom substation card containing relay information.

(iii) Testroom relay card.

(iv) Page of testroom relay book.

(v) Planning division substation master file(transformers).

(vi) Planning division winter load summary.

(vii) Planning division substation round.

(viii) Planning division work instruction sheet.

(ix) Drawing office substation card.

(x) Drawing office cable lengths, joints cards(2)

(xi) Substation division kiosk card.

(xii) Substation division auxiliary/ voltage transformer cards.

(xiii) Substation division fuse switch card.

(xiv) Substation division magnefix card.

(xv) Substation division switchgear cards(3).

MUNICIPAL ELECTRICITY DEPARTMENT, CHRISTCHURCH. N.Z. 27

TRANSFORMER CARD.4.

MAKER: [illegible]
SIZE KVA: [illegible]
Date of Purchase: [illegible]
Phase and Ratio [illegible]
Price: 255
Taps: [illegible]
Serial No.: [illegible]
Type: [illegible]
Oil Gals: [illegible]
Weight lbs:
Dim's: H [illegible] W [illegible] D [illegible]

Date	Where Installed	Remarks
Dec '50	Recd.	
7 May 53	Bellevue Tce [illegible]	
6-11-58	[illegible]	[illegible] by 200 KVA.
19-11-58	[illegible]	[illegible]
18-4-59	[illegible]	[illegible] P.C. 150 [illegible]
17-4-[illegible]	Burwood Rd No. [illegible]	[illegible] sub.
14-4-69	Acidity Test ·59 MG/KOH/G.	
6-11-69	Removed from Service	Replaced by P.C. 200.
		P.T.O.

Date	Where Installed	Remarks
20-11-69	Middle Lincoln Rd 574. Pole Sub.	Replaces P.C. 50 KVA.
1-8-72	Name Changed to Wigram Road South.	

M.E.D. SUBSTATION HEATHCOTE 11 kV

ROOM A

SWITCHGEAR MAKE	TYPE	UNITS	kV	RATING	DRAWING Nos.
S.W.S.	CB	14	11	350. MVA	CT-s:
G.E.C.	"	12	11	350	

UNIT No.	TYPE	FEEDER	CABLE	CT-s	RELAY	O/C			E/L		NOTE
1	CB	LYTTELTON B.C. OH	·5	~~400~~ 800/5	CDG 36	2.5	·3				3,9,[illegible]
			Metering	400-200/5	CTU 11				·5	1.5	
				400-800/1	VAR42	Clos	5s	[illegible]	[illegible]		19
2	"	T1 Bank A Cables	2×·5	2400/1 1200/5	—	75%					
3	"	Chapmans Rd [illegible]	·5	800/5	CDG.31	2.5	0.2				4,11,16
		[illegible]		400-800/1	S/R						
					~~CTU 11~~				0.5	2.0	
4	"	[illegible]		800/5							
				400-800/1							
5	"	Barnett Park No1 OH	·5	800/5	CDG 31	3.75	·25				6
					CTU 11				0.5	1.5	
				400-800/1							
6	"		·1	800/5	CDG 31	2.5	·05				10.
				400-800/1							
7	"	A Bus Section		1200/5	—						

M.E.D. SUBSTATION HEATHCOTE 11kV

SWITCHGEAR MAKE	TYPE	UNITS	kV	RATING	DRAWING Nos.
				MVA	CT-s:

UNIT No.	TYPE	FEEDER	CABLE	CT-s	RELAY	O/C			E/L		NOTE
8	CB	Maunsell St E.	·5	800/5	CDG 31	75%	·3				5,1,
					S/R						
9	CB	Ferrymead O/H (future)		400-800/1	S/R						
				800/5	CDG 31						
					CTU 11						
10	CB	Riffle Plant	·1	400-800/1	S/R	NOT	IN	SERVICE			B
				100-400/5	CDG66	3.75	·1	20×			8
11	CB	N.Z.E.D. Lyttelton No 2	·5	800/5	CDG 36	2·5	·3				3,9
			Metering	400-200/5	CTU 11				·5	1·5	
				400-800/1	VAR42		5/60 sec				19,A,
12	CB	T1 Bank B Cables	2×·5	1200/5 2400/1	—						
13	CB	Barnett Park No2 O/H	·5	800/5	CDG 31	3·75	·25				6,13,
					CTU 11				·5	1·5	
				400-800/1							
14	CB	B Bus Section		1200/5							18

COMMENTS ON REVERSE

M.E.D. RELAY

MAKE ASEA TYPE R1 RATING 5A SER. No. 83851-10
RANGES 1 – 6 SEC 2·5 – 10 AMPS 0000 M.E.D. No. 547

Bullivant 3339

DATE	SUBSTATION	FEEDER	PHASE	Ret.	REMARKS
16. 1950	HOONHAY	SPARKS RD O.H.	RED	17.9.70	
-12-70	DAVIS GELATINE				

4B3 & 2B3 RELAYS

	[illegible]	[illegible]	[illegible]	[illegible]	TESTED	[illegible]
	G2Z 1544	30-1-69	HEATHCOTE	T1		
	1563	"	"	T1		
	1576	"	"	T2		
	1555	"	"	T2		
	E2Z 856	4-6-69	HAWTHORNDEN			
	1807	"	"			
	1811	11-6-69	ISLINGTON			
	1815	"	"			
	1826	15-9-69	HOON HAY			
	1831		"			
	1845	"	HOON HAY			
	1846					
	E3A 2704	15-1-70	DALLINGTON	TP 1		
	2713	"	"	TP 2		
	2716	9-3-70	BROMLEY			
	2719	"	"			
	E3A 3254	5-9-72	McFADDENS	TP1		
	3267	"	"	TP2		
	A3B 1795	1-6-71	MILTON			
	C3B 285	"	DALLINGTON	G.P		
	286					
	289					
	301	16-2-73	McFADDENS	G.P		
	303	4-12-73	OXFORD-TUAM	T1		
	306	6-4-73	PAPANUI			
	315					
	326	4-12-73	OXFORD-TUAM	T2		
	331	"	" "	G.P		
	332	9-4-73	PAPANUI			
	334	12-12-73	ADDINGTON			
	336	"	"			
	341					
	C3D 93					
	2143					
	B3F 703	2-9-75	HALSWELL	132		DRAWOUT CASE
	707	2-9-75	HALSWELL	192		"
	710	23-2-76	BRIGHTON	T1		"
	721	23-2-76	"	T2		"
	739	23-2-76	"	T1		"
Received 2-7-75	B3F 1921	23-2-76	"	T2		"
	1930	30-11-76	PAGES - KEARNEYS			"
	1934					"
	2154		WOOLSTON			RIPPLAY PLANT.
RECEIVED 2-5-79	100803	18-2-80	MILTON		7-8-79	4B3 VEDETTE CASE
	804	"	"		"	" " "
	805	"	"		"	" " "
	806	"	"		"	" " "

SUBSTATION MASTER FILE

31 MARCH 1983
[O=O'LOAD CATEGORY]

SUBSTATION SYSTEM NAME (OTHER LOCAL NAME)	SUB POSN	TRANSFORMER KVA	TYPE	O	ROUND NO	GRID REFS	DRWG NO	MXTAP
A.B.CONSOLIDATED	BLDG		HVC		112	13D4	P35	
ABBERLEY CR	HI K	300		3	66	6G2	E35	
ABBEY PL	LO K	200		5	69	8B1	AY32	
ABERDEEN ST # 30	LO K	300		4	42	12E6	J33	
ACACIA AV	LO K	200		5	30	11G2	P44	
ACHESON AV	HI K	300		3	70	7D2	A31	
ACTON ST # 10	LO K	300		4	112	13E5	P35	
ADAMS PL	HI K	200		4	9	20D2	W27	
ADMIRALS WAY	LO K	200		5	91	9F6	F18	
AIKMANS RD	HI K	300		3	47	12B3	F37	
AILSA ST	LO K	300		4	70	8E2	C31	
AKAROA ST (NO 1 STREET)	BLDG	500		2	70	8C2	AZ31	
(NO 2 W.W.)		200		5	70	8C2	AZ31	
AKELA ST	HI K	300		3	47	12B3	E37	
ALBANY ST	LO K	300		4	66	6H2	E35	
ALCESTER ST	BLDG	750		2	110	13E5	245155	
ALDERSHOT ST # 72	HI K	300		3	95	9G2	E23	
ALDWINS RD # 45	LO K	200		5	1	20A1	133079	
ALDWINS RD # 54	LO K	300		4	1	15G3	133078	
ALDWINS RD #108	LO K	200		5	102	15G3	134078	
ALDWINS RD #179	LO K	200		5	101	15G3	013477	
ALDWINS RD EDMONDS	LO K	300		4	1	20A2	133079	
ALFRED ST	BLDG	750		2	103	15G2	P31	
ALLOWAY ST	LO K	200		5	84	16A3	B25	
ALMA PL	HI K	300		3	71	8D3	B29	
AMBLESIDE DR # 23	HI K	300		3	53	4F2	A45	
AMBLESIDE DR # 61	LO K	200		5	53	4H3	103068	
AMOS PL	HI K	200		4	71	8D2	A29	
AMURI MOTORS	BLDG	500		2	108	13A4	243150	
ANDREWS CR	HI K	200		4	22	18B4	T37	
ANGLESEA AV # 1	LO K	200		5	87	9A1	AP23	
ANNEX RD ANDREWS & BEAVEN	BLDG	500		2	30	11H1	R44	
ANNEX RD N	HI K	200		4	30	11H2	Q44	
ANTHONY RD	POLE	30		6	93	9G3	A3037	
ANTIGUA ST #122	LO K	300		4	21	13H4	R35	
ANTIGUA ST #134	LO K	200		5	21	13H4	R35	
ANTIGUA ST #191	LO K	300		4	24	13G2	P35	
ANTIGUA ST #194	OUTD	500		2	24	13G2	Q35	
AORANGI RD # 78	LO K	300		4	50	11A2	B41	
AORANGI RD #110	LO K	200		5	55	11A2	B42	
AORANGI RD #125	HI K	300		3	55	11A2	C42	
AORANGI RD #177	HI K	200		4	54	11B2	D43	
AOTEA TR # 50	LO K	200		5	10	19H4	BB30	
APOLLO PL	LO K	300		4	64	5C6	116064	
APPLEBY CR	HI K	300		3	53	4G3	AZ45	
APPLEWOOD PL	LO K	200		5	60	4B6	AT41	
ARANUI HIGH SCHOOL	LO K	300		4	95	9H2	F23	
ARAWA ST	HI K	200		4	70	8E4	C30	
ARLINGTON ST	HI K	300		3	52	4F1	A47	
ARMAGH (T1)	DIST	20M	66KV	7	106	14D4	248150	
(T2)		20M	66KV	7	106	14D2	248150	

1982 WINTER LOAD SUMMARY

11/.4KV TRANSFORMERS AND H.V. CONSUMER

SUBSTATION SYSTEM NAME (OTHER LOCAL NAME)	SUB POSN	TRANSFORMER KVA	TYPE	O	PHASE CURRENTS RED	YELL	BLUE	DIAGNOST AVGE	%FL
WILSONS RD #258	LO K	200		5	300	260	280	280	100F
WILSONS RD #284	BLDG	1000	3*1P	1	600	510	540	550	39
WILSONS RD #338	BLDG	500		2	600	600	480	560	80
WILSONS RD POOL	HI K	300		3	200	280	220	233	55
WILTON CR	HI K	300		3	320	420	400	380	91
WIMBORNE CR	HI K	300		3	300	280	300	293	70
WINCHESTER ST # 69	LO K	200		5	350	280	280	303	109F
WINCHESTER ST N	HI K	300		3	300	260	380	313	75
WINCHESTER ST S	BLDG	500		2	390	510	420	440	63
WINDERMERE RD # 69	LO K	300		4	360	330	360	350	84
WINGATE ST # 20	HI K	300		3	320	300	280	300	72
WINGATE ST # 75	LO K	200		5	280	270	290	280	100F
WINSLOW ST	HI K	200		4	120	110	150	126	45
WINSOR CR	HI K	200		4	250	260	250	253	91
WINSTON AV	LO K	300		4	370	370	430	390	93
WINTERS RD #224	POLE	100		6	54	72	90	72	51
WINTERS RD W	HI K	200		4	380	390	310	360	129O
WIREMU ST	LO K	200		5	100-	100-	100-	75	27
WITBROCK CR # 14	LO K	200		5	220	240	250	236	84
WITHELLS RD #120	LO K	300		4	330	330	300	320	76
WITHELLS RD #272	LO K	200		5	340	420	380	380	136O
WITHELLS RD #369	HI K	200		4	100-	100-	100-	75	27
WITHELLS RD N	POLE	300		5	580	580	590	583	139O
WITTYS RD	LO K	200		5	280	300	340	306	110F
WOODARD TR (NO 1)	BLDG	300		4	380	320	410	370	88
(NO 2)		300		4	440	310	400	383	91
WOODBANK ST	HI K	200		4	320	260	260	280	100F
WOODBURY ST # 15	HI K	200		4	220	360	300	293	105F
WOODBURY ST W	LO K	200		5	240	140	260	213	76
WOODFORD TR # 18	LO K	300		4	320	240	280	280	67
WOODGROVE AV	LO K	200		5	360	260	270	296	106F
WOODHAM RD # 73	HI K	300		3	410	430	480	440	105F
WOODHAM RD #271	BLDG	750		2	780	660	600	680	65
WOODLANDS PL	LO K	200		5	230	210	230	223	80
WOODVILLE ST	LO K	300		4	370	390	430	396	95
WOOLDRIDGE RD #281	POLE	200		6	222	252	276	250	90
WOOLLEY ST	HI K	200		4	270	320	240	276	99
WOOLSTON	DIST	750		2	450	475	450	458	43
WOOLSTON PARK	BLDG	600	3*1P	2	510	540	300-	425	51
WORCESTER ST # 65	HI K	200		4	170	160	150	160	57
WORCESTER ST #303	LO K	300		4	370	330	280	326	78
WORCESTER ST #388	LO K	500		2	672	592	544	602	86
WORCESTER ST #585	HI K	300		3	420	350	380	383	91
WORCESTER ST #641	HI K	300		3	280	240	320	280	67
WORCESTER ST POSTAL CENTRE(PO)	BLDG		HVC		1040	KVA			
(ST)		500		2	390	300	300	330	47
WORCESTER ST W	BLDG	1000	3*1P	2	1200	1200	1080	1160	83
WORDSWORTH ST # 49	BLDG	750		2	980	930	930	946	90
WORDSWORTH ST #125	BLDG	750		2	900	750	900	850	81
WORDSWORTH ST E (NO 1 STREET)	HI K	200		4	250	280	320	283	101F
(NO 2 FACTORY)		300		3	0	0	0		

SUBSTATION ROUND NO 2

28 FEBRUARY 1983
(O=O'LOAD CATEGORY)

SUBSTATION SYSTEM NAME (OTHER LOCAL NAME)	SUB POSN	TRANSFORMER KVA	TYPE O	MDI MULT	PHASE CURRENTS (AMPS) RED	YELL	BLUE	TEMP	EARTH CHECKED
MAJOR HORNBROOK RD # 39	HI K	300	3	100					
MT PLEASANT RD #122	LO K	200	5	100					
MAJOR HORNBROOK RD #106	BLDG	300	4	100					
CANNON HILL CR #231	LO K	200	5	100					
CANNON HILL CR #259	HI K	200	4	100					
HILLTOP LN	HI K	200	4	100					
MURITAI TR	POLE	300	5	100					
BELLEVIEW TR	POLE	200	6	60					
MT PLEASANT RD #228	POLE	200	6	60					
SOLEARES AV S	LO K	300	4	100					
MT PLEASANT RD #272	POLE	200	6	60					
MT PLEASANT RD #339	POLE	50	6	20					
MT PLEASANT RADIO	HI K	50	6	20					
SUMMIT RD	HI K	25	6	20					
MONCKS SPUR RD UPPER	POLE	100	6	40					
MONCKS SPUR RD #138	POLE	200	6	60					
MONCKS SPUR RD # 80	LO K	300	4	100					
MONCKS SPUR RD LOWER	HI K	200	4	60					

Mr Wily ✓
Mr Spence
Mr Christensen
Mr Mehta
Mr Henden
Mr Poole
Mr Barrett
Mr Nelson
Mr MacAlpine
File 22/40/1A

PROGRAMME: Lay L.V. cable in Oxford Terrace for load relief and do other work as below.

COMPLETION: Immediately.

ISSUED: 7th July 1983 BY PLANNING DIVISION: RJK.

WORK INSTRUCTION SHEET

WIS NO. 1455 SHEET: 1 of 1

OTHER:

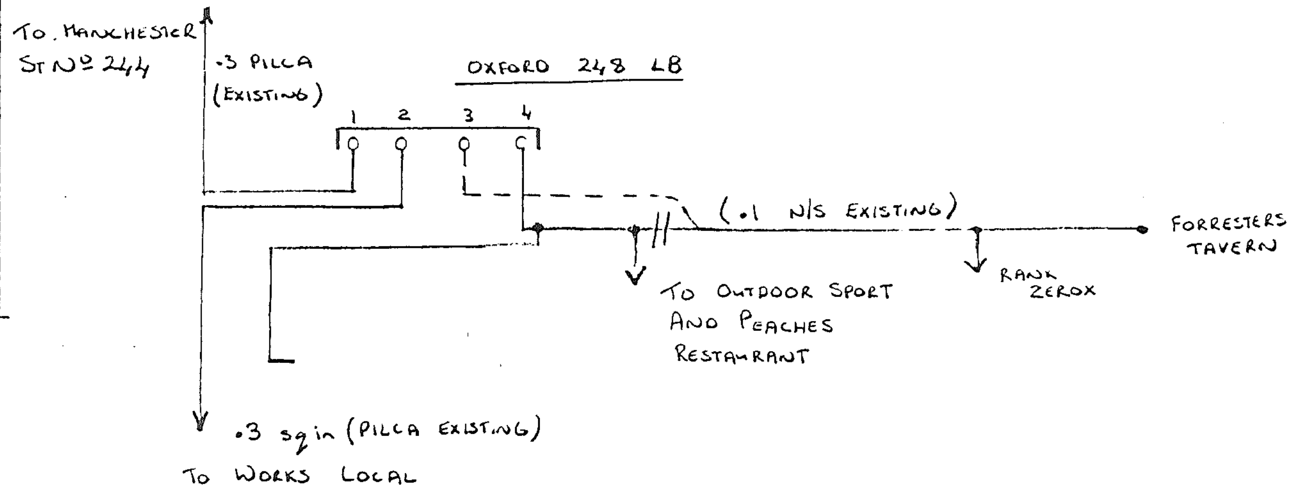
P.F. NO.: "X" ORDER NO.

11 kV Switchgear: FAULT RATING: MVA

C.B. F.S. A.I.U.

TRANSFORMERS: KVA

RELAYS	SWITCHGEAR	REF	CABLE	LENGTH (M)	WORK DETAILS
		Cct 3	$70mm^2$ N/S		At Oxford 248 L.B. Lay cable in south side of Oxford Terrace East to a suitable through joint position east of service to Outdoor Sport Shop and Peaches Restaurant, as indicated on diagram. Cut existing .1 N/S cable in south side Oxford Terrace East and through joint east end to the $70mm^2$ N/S cable from Oxford 248 L.B. (Circuit 3). Insulate west end of the cut .1 N/S cable.



L.V. CIRCUITS:

PLANNING ENGINEER:

CHARGE:

DARLINGTON DISTRICT SUB.

SUB STATION CARD 1

BUILDING DRGS.	SITE DRGS.
B3957	C3319
B4429	D3896
B4449	C3967
A4650	D4538.
B5436	B5632

P.T.O.

CONSTRUCTION DETAILS

OVERALL SIZE	65'4" x 39'4"				
ROOF	~~GI~~	conc.			
WALLS	~~brick~~	block	~~conc.~~		
DOWN PIPES	int.	~~ext.~~	CU	~~GI~~	
~~GUTTERS~~	~~int.~~	~~ext.~~	~~CU~~	~~GI~~	
DOORS	steel	~~timber~~			
BUILT	1968.				

MAINTENANCE

ROUTINE CHECK	DATE	3/75					
PAINTED	DATE	Exterior 3/77	Interior 1978				
SILICONED	DATE						
OTHER	DATE						
	TYPE						

REMARKS:

Bulliva

BOTH SIDES OF THIS CARD ARE FOR BUILDING DATA ONLY

MONTROSE ST.

SUB STATION CARD 1

BUILDING DRGS.	SITE DRGS.
A1253	C2615
	C2637.

CONSTRUCTION DETAILS

OVERALL SIZE	20'0" x 18'0"				
ROOF	~~GI~~	conc.			
WALLS	~~brick~~	block	conc.		
DOWN PIPES	int.	~~ext.~~	CU	~~GI~~	
~~GUTTERS~~	~~int.~~	~~ext.~~	~~CU~~	~~GI~~	
DOORS	~~steel~~	timber			
BUILT	1963				

MAINTENANCE

ROUTINE CHECK	DATE	3/75					
PAINTED	DATE	Doors/75 Roof/75	Doors 1980				
SILICONED	DATE	1970					
OTHER	DATE						
	TYPE						

REMARKS:

Bulliva

BOTH SIDES OF THIS CARD ARE FOR BUILDING DATA ONLY

CABLE ROUTE HALLS RD - TEE JOINT (WRIGHT RD) Index No. 2231

TYPE 3c 11kV PILC SIZE .06 LAYING DATE 1973

Bullivant 2037 1M/8/70

Joint Number	Distances METRIC		U/G Sheet No.	Make	Remarks
T.E. HALLS RD	0.00	97.5	S41	ABCAL E/2	
TEE JOINT	97.5	0.00	S41		SEE CARD 3343

CABLE ROUTE NORWICH ST - LINWOOD AVE. No.257 Index No. 3343

TYPE 3c 11kV PILCA SIZE .04 & 25mm² CU LAYING DATE 1969 & 1980

Bullivant 1323 1M/11/77

Joint Number	Distances		U/G Sheet No.	Make	Remarks
T.E. NORWICH ST	0.00	235.00	135.76		$\cdot 25mm^2$
JOINT NO.1	192.50	42.50	135.76		
T.E. LINWOOD AVE	235.00	0.00	135.77		.04

CABLE ROUTE WRIGHTS RD Nº 112 - TORRENS RD Index No. 3340

TYPE 3C 11KV PILCA SIZE ·15 AL LAYING DATE 1973

Bullivant 1323 1M/11/77

Joint Number	Distances		U/G Sheet No.	Make	Remarks
WRIGHTS ROAD #112	0·00	704·75	R 41	ABCAL E/2	
TEE JOINT Nº 1	74·75	630·00	S41		SEE CARD 2231
JOINT Nº 2	130·75	574 00	S 41		
JOINT Nº 3	438 75	266·00	T41		
TE TORRENS ROAD	704 75	0·00	T41.		

KIOSK [redacted] SUBSTATION *Battersea Street East*

20

SITE *Sydenham off Colombo St at rear of CSB. Bldg.* DRAWING No. *19A2* *Low Type ~~No.~~ No. 818.*

TRANSFORMER					
SERVICE DATE	27·7·73.				
K.V.A.	500				
MAKE	P.C. Low Type				
SERIAL No.	15829				
TAP SETTING	10,725V				

H.T. *Magnefix 2KBK No 3L107*

UNIT 51 *Wordsworth St. No 49, Orbell St. No 79*

UNIT 55 *Zoo...*

L.T. PANEL ~~SYNDANYO~~ *A4617-2* SKELETON ~~PROTECTOR~~ ~~MARBLE~~

UNIT 58 *Transformer*

CIRCUIT	CABLE	S/L	HANDLE	LINK	AMPS	C.T. RATIO	S/L FUSE PHASE		S/L CONTROL
TOTAL			Isolator	Switch	800 A.	800/5			~~R.R.~~
1	70mm		Ceram	DL2	200				~~CONT.~~
2	0.3 XLP	✓	"	"	400 ~~300 A.~~				
3	~~0.3~~ 70mm NS	✓	"	"	260				
4	70 NS		"	"	260				
5									
6									

Kiosk *Battersea Street East*

LABELS TYPE C2331 ITEM

Cct 1 70 + 35 N.S. sym. TNS END W SIDE COLOMBO ST N ALSO W SIDE COLOMBO ST S TO CLOB ...ER IJ COLOMB ST No 441	Cct 2 0.3 sym XLP. Battersea St. O.H.	Cct 3 70mm N.S. To Colombo 380 LB Cct 1 N SIDE BATTERSEA E. E SIDE COLOMBO S LOOP IN WORDSWORTH ST
CT 4 70 N.S. TO C.S.B. SIDE BATTERSEA ST E.		h-35

No. 3—1,000 Bullivant 8143

MUNICIPAL ELECTRICITY DEPARTMENT, CHRISTCHURCH, N.Z.

Auxiliary. TRANSFORMER CARD

Maker G.E.C.-A.E.I. KVA: 15

Contract O/n 909 Spec. No. 548 Phase and Ratio: 3ø 11kv/415v

Price: Inc. with Swgr. Type O.N. Serial No. 16361

Ext. Taps Impedance:

Oil Gals: Weight Dim's: H L D

S.G. Breather: Conservator: Max. Ind. Thermometer

Cable Boxes: H.T. L.T.

Date	
	Received: 26th January 1973
12:4:73.	Taken to McFaddens on Unit 23

1000/12/72 Bullivant 5586

MUNICIPAL ELECTRICITY DEPARTMENT, CHRISTCHURCH, N.Z.

Voltage. TRANSFORMER CARD

Maker G.E.C. A.E.I. KVA: 800

Contract O/n 909 Spec. No. 546 Phase and Ratio: 3ø 11kv/~~415v~~ 11?v

Price: Inc. with Swgr. Type O.A.N. Serial No. 34038

Ext. Taps Impedance: Class B.

Oil Gals: Weight Dim's: H L D

S.G. Breather: Conservator: Max. Ind. Thermometer

Cable Boxes: H.T. ~~L.T.~~ NEUTRAL EARTHED

Date	
	Received: 26th January 1973
12:4:73.	Installed at McFaddens on Unit 15

1000/12/72 Bullivant 5586

11. kV

MUNICIPAL ELECTRICITY DEPARTMENT, CHRISTCHURCH, N.Z.

SWITCHGEAR CARD

Maker BRUSH. MVA 400

Type H. F. U. SWITCH FUSE. Amps 400

Contract O/6A. Date BRUSH CONTRACT. Serial No 05/64278-28

Spec. No. 512. W.O. No. 05/64298.

		MAKER	M.E.D.	RELAY TYPES
Drawing Nos.	Wiring	E.5971353.	DM.286	
	Layout	A5154940	AM.271.	

			C.T. RATIOS
Tripping	Shunt	~~Volts~~ D.C.	
	Series	Amps	
	Non-Auto.		
Closing			

Bullivant 480

DATE	Received 5.10.65. DETAILS Prior 276
9-5-67	Woodham Road. Unit. 15.
30-9-69	Name change. Woodham Rd No 271
20-1-81	Removed from service

MUNICIPAL ELECTRICITY DEPARTMENT, CHRISTCHURCH, N.Z. [illegible]

11 kV

SWITCHGEAR CARD

Maker Reyrolle Parsons of NZ Ltd Serial No.: F 355

Type [illegible] Integral Earthing — MVA 250

Contract C/N 1164 Date ...... Unit Amps 400

Spec. No. P 2056 W.O. No. — Busbar Amps 400

		MAKER	M.E.D.
Drawing Nos.	Wiring		
	Layout		

RELAY TYPES

Tripping	Shunt	Volts D.C.
	Series	Amps
	Non-Auto.	Ohms
Closing	Solenoid Release	Volts D.C.
	Spring (Hand / Motor) Assisted	Amps
	Manual	Ohms

C.T. RATIOS

1000/12/72 Bullivant 5585

DATE	DETAILS
	Rec'd 12·8·77 Price $.1340
22·8·77	Installed @ Pages Kearneys Rd. Dist. Sub.

11kV

MUNICIPAL ELECTRICITY DEPARTMENT, CHRISTCHURCH, N.Z.

MASTER SWITCHGEAR CARD DALLINGTON

Maker SOUTH WALES Serial No.: ——

Type D6X4 E D8/12X1 Integral Earthing ✓ MVA 350

Contract MED O/N 440 Date 24:10:67 Unit Amps D6X4 = 600 D8/12X1 = 1200

Spec. No. MED 445 W.O. No. 47244 Busbar Amps 1200

		MAKER	M.E.D.	RELAY TYPES
Drawing Nos.	Wiring	A26109-110-111-	AM 439-440-	
		112-113/3	441-442-443	
	Layout	A26444/2	AM 462	

				C.T. RATIOS
Tripping	Shunt ✓		50 Volts D.C.	
	Series		Amps	
	Non-Auto.		Ohms	
Closing	Solenoid Release		50 Volts D.C.	
	Spring (Hand / Motor) ~~Assisted~~ 240 Volt		Amps	
	~~Manual~~		Ohms	

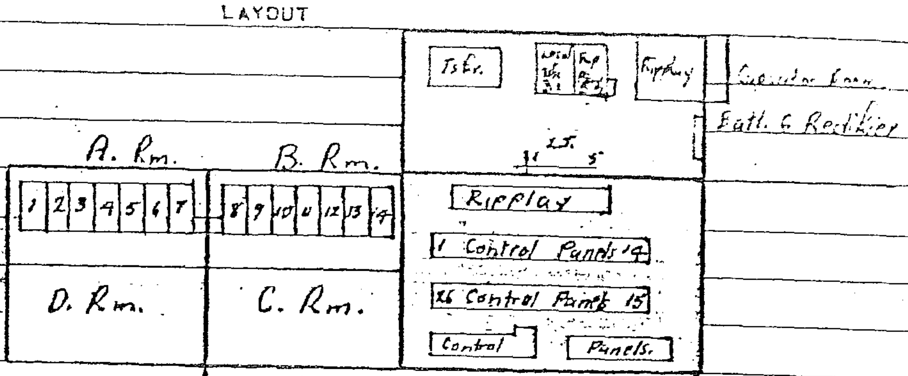
1000/10/68 Bullivant 9107

[illegible] DISTRICT [illegible]

REMARKS

[illegible]

LAYOUT



UNIT No.	H.T. LABELS	UNIT No.	H.T. LABELS
1	RETREAT RD E 172	10	Golf Links Rd. S Unit No 33
2	T1 A Cables	11	Lake Ter. Rd. No 5 36.
3	AVERILL ST Unit 11 [illegible]	12	T1 B Cables
4	Golf Links Rd. S. Unit No 13	13	Local & Ripplay
5	New Brighton Rd. No 111		
6	Spare	14	B – C Bus Section
7	A – B Bus Section		
8	HILLS Rd 130		
9	Gayhurst Rd. No 152		

Building Dallington District (Local L.T Panel)

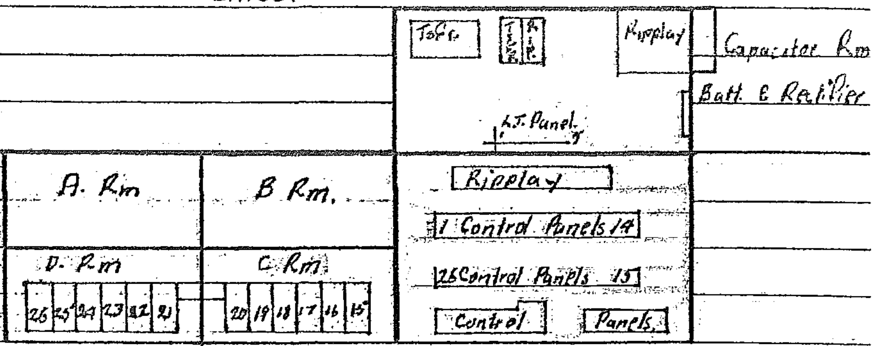
LABELS TYPE C2331 ITEM

Cct 1 Sqin	Cct 2 0·06 sqin Ripplay	Cct 3 0·0225 sq in Filter Supply (T_2 M.K.)
Cct 4 0·0225 sqin Aux. Supplies Cabinet	Cct 5 0·3 sqin To O.H. Coopers Rd.	

BUILDING SUBSTATION Darlington District (Rooms C and D)

REMARKS

LAYOUT



UNIT No.	H.T. LABELS	UNIT No.	H.T. LABELS
15		24	T2 D CABLES
16	T2 C CABLES	25	
17		26	~~D BUS SECTION~~ D-A Bus S
18			
19	MARSHLAND RD O.H.		
20	~~C BUS SECTION~~ C-D Bus Section		
21	AVERILL ST. UNIT 21		
22			
23			

APPENDIX (II)

MED Power Network Database, Data Dictionary -Final Version.

The following is a list of all information items to be included in the proposed MED database. The list effectively defines the scope of the database- what is included and what is excluded.

Data items are listed in alphabetical order. They are restricted in length to eight characters or less for reasons of brevity and compatibility with computer systems. Qualifiers(B_,C_,etc) have been used to group items of information into common groups. The name of each piece of information is the name by which the data item will be known within the proposed database. The database name is a just a label for an existing item of information. In many cases it is the same as the common MED term presently used in references to an information entity.

Each data item has an associated description and an example given. These two descriptive features identify exactly what information item the database name refers to. A Format for each item is listed to indicate the size of the item.

The following format convention is used:

- I : integer (a whole number, no fractional part)
- F : floating point (any number, with or without fractional part)
- X : characters (any character available from the keyboard can be stored)

Examples: 2I, two integers,
3F, three real numbers,
3X10, three character strings ,each ten characters long.

Also given is the 'owner' or the most interested party of each data item. For example, Substations are the most interested people when regarding switchgear information, and they also hold most of the information concerning switchgear. Obviously information items can be useful for many different purposes, and often when determining an item 'owner' or source the process is a little arbitrary.

Owners

- S : Substations
- P : Planning
- T : Test room
- C : Cables
- D : Drawing office
- W : Wiring
- CR: Control room

Item name	Description	Example	Format	Owner
All Insulated Units				
AIU_AMPS	Amp rating	300	I	S
AIU_CNFG	Configuration description	Left mount. box	X32	S
AIU_DATE	Purchase date	12/12/79	2I	S
AIU_DLAB	Destination label	Local transfmr	X64	S
AIU_MAKE	Manufacturer	Reyrolle	X16	S
AIU_MVA	MVA size	350	I	S
AIU_ORDR	Order(contract) number	490	I	S
AIU_PRCE	Price	12 000	F	S
AIU_REMK	General remarks	Repaired 12/82	X32	S
AIU_RATG	Rating	300	I	S
AIU_SERN	Serial number	E07124	X16	S
AIU_STAT	AIU link status,open,closed	OPEN	X8	P
AIU_TYPE	Switchgear type(model variety)	D6X4	X8	S
AIU_UNIT	Unit/panel number	54	I	S
AIU_VARY	Variety	Magnefix	X8	S
AIU_VOLT	Voltage	11000	F	S
Auxiliary transformers				
AT_COST	Purchase cost/price	1206.58	F	S
AT_DATE	Purchase date	12/12/81	2I	S
AT_KVA	KVA rating	30	I	S
AT_MAKE	Manufacturer	GEC	X16	S
AT_ORDER	Order number	230	I	S
AT_PHASE	Phase	3	I	S
AT_PURP	Purpose/function	Metering	X12	S
AR_RATIO	Ratio	11000/415	2I	S
AT_REMRK	Remarks,general comments	In service	X32	S
AT_SERNO	Serial number	AD12056	X16	S
AT_SPEC	Spec number	201	I	S
AT_TYPE	Transformer model type	DA11	X8	S
Branches				
B_BOTNOD	Node within 'bottom' substation.	Switchgear RM 2	X32	P
B_BOTSUB	Substation at the 'bottom' of the sequence of elements which form a branch.	Dallington	X32	PD
B_INDEX	Drawing office cable index number	2231	I	PD
B_TOPNOD	Node within 'top' substation.	Switchgear RM 2	X32	P
B_TOPSUB	Substation at the 'top' of the sequence of elements which form a branch.	Dallington	X32	PD

Item name	Description	Example	Format	Owner
Cables				
C_LENGTH	Length	100	I	CD
C_MAKE	Manufacturer	GEC	X16	CD
C_NUMBER	Individual cable identifier	1779	I	CD
C_SIZE	Size,cross_section	.04	F	CD
C_TYPE	Material/brand name	AL	X8	CD
C_UGSHT	Underground sheet number	R41	X8	CD
C_YEAR	Year of laying	1968	I	CD
Circuit Breakers				
CB_BUSAM	Busbar amps	1200	I	SD
CB_CLOSG	Closing type	Solenoid	X16	S
CB_CPWR	Closing power	50	I	S
CB_DATE	Purchase date	12/12/79	2I	S
CB_DESLB	Destination Label	English St.	X64	S
CB_DESND	Destination node for outgoing cable	HV Switchgear	X32	P
CB_DESUB	Destination sub for outgoing cable	English St. Sub	X32	P
CB_DLAYT	Drawing numbers(MED):layout	A0003	2X8	SD
CB_DMLYT	Drawing numbers(Maker):layout	AM456	2X8	S
CB_DMWG	Drawing numbers(Maker):wiring	AM362	2X8	S
CB_DWIRG	Drawing numbers(MED):wiring	AM498	2X8	SD
CB_EARTH	Integral earthing available?(y/n)	Y	X	S
CB_LABEL	Whether CB has been labelled(Y/N)	Y	X	CR
CB_LOCKD	Whether CB has been locked(Y/N)	N	X	CR
CB_MAKE	Manufacturer	South Wales	X16	S
CB_MVA	MVA size	350	I	S
CB_NSEQ	Whether CB's node location is top or bottom of the branch including CB.	Top	X6	P
CB_OPEN	Open(closed) status(O/C)	C	X	CR
CB_ORDER	Order(contract) number	490	I	S
CB_PANEL	Circuit breaker panel number	15	I	S
CB_POSIT	CB postion	Isolated	X12	CR
CB_POWER	Tripping power size	50	X8	S
CB_PRICE	Price	12000	F	S
CB_REMRK	General remarks	Repaired 12/82	X32	S
CB_SERNO	Serial number	E07124	X16	S
CB_SPEC	Spec number	1203	I	S
CB_TAG	Tagged status(y/n)	Y	X	CR
CB_TAGNM	Owner of tag	Axford	X16	CR
CB_TRIPG	Tripping type	Shunt	X8	S
CB_TYPE	Switchgear type(model variety)	D6X4	X8	S
CB_UAMPS	Unit amps	600	I	S
CB_VOLT	Voltage	11000	F	S
CB_WONO	Work order number	05/64298	X8	S

Item name	Description	Example	Format	Owner
Pilot cable circuits				
CR_NUMBR	Circuit number(unique identifier)	203	I	W
CR_PURPS	Circuit function or purpose	PAX phone 749	X32	W
Branch elements				P
E_INDSEQ	Drawing office index number(sequence)	6	I	PD
E_SEQ	Sequence,element sequence in branch	10	I	P
E_TYPE	Element type	Isolator	X16	P
Fuse Switches				
FS_BUSAM	Busbar amps	1200	I	SD
FS_DATE	Purchase date	12/12/79	2I	S
FS_DESLB	Destination label	Berry St.	X64	S
FS_DESND	Destination node for outgoing cable	HV Switchgear	X32	P
FS_DESUB	Destination sub for outgoing cable	English St. Sub	X32	P
FS_DLAYT	Drawing numbers(MED):layout	A0003	2X8	SD
FS_DMLYT	Drawing numbers(Maker):layout	AM456	2X8	S
FS_DMWG	Drawing numbers(Maker):wiring	AM362	2X8	S
FG_DWIRG	Drawing numbers(MED):wiring	AM498	2X8	SD
FS_MAKE	Manufacturer	South Wales	X16	S
FS_MVA	MVA size	350	I	S
FS_ORDER	Order(contract) number	490	I	S
FS_NSEQ	Whether FS's node location is top or bottom of the branch including FS.	Top	X6	P
FS_PANEL	FS panel number	15	I	S
FS_PRICE	Price	1200	F	S
FS_REMRK	General remarks	Repaired 12/82	X32	S
FS_SERNO	Serial number	E07124	X16	S
FS_SPEC	Spec number	1203	I	S
FS_TYPE	Switchgear type(model variety)	D6X4	X8	S
FS_VOLT	Voltage	11000	F	S
FS_WONO	Work order number	05/64298	X8	S
Isolators,Sectionalizers,Reclosers				
I_INITAL	Initials(R41,S22 etc.)	R	X2	CD
I_OPEN	Whether Isolator is open or closed(O/C)	O	X	CD
I_LABEL	Whether Isolator has been labelled(Y/N)	Y	X	CD
I_LOCKED	Whether Isolator has been locked(Y/N)	N	X	CD
I_MAKE	Manufacturer	Canty Eng.	X16	CD
I_NUMBER	Number(unique identifier)	47	I	CD
I_TAGGED	Whether Isolator has been tagged(Y/N)	Y	X	CD
I_TAGNAM	Name of person who tagged Isolator	C. Axford	X16	CD
I_TYPE	Recloser,load break,air break etc.	Air break	X6	CD
I_YEAR	Year of installation	1968	I	CD

Item name	Description	Example	Format	Owner
Land				
L_ADATE	Agreement date	121279	2I	P
L_ADDRSS	Common address	10 Chapman RD	X32	P
L_BODY	Local body	Christchurch CC	X16	P
L_COT	Certificate of Title	A30971	X16	P
L_EXDATE	Lease expiry date	131289	2I	P
L_GRIDNO	Map grid number	08F4	X4	PD
L_LDESCP	Legal description	SR12 Lot3	X20	P
L_MEDNAM	MED name	Chapman RD	X32	P
L_PONAME	Post Office name	Chapman RD 1t15	X32	P
L_REMARK	Comments	Swampy land!	X32	P
L_SITE	Site type(barren land ,sub etc.)	Switchyard	X16	P
L_TENURE	Tenure type	Rental	X16	P
L_VALUE	Valuation role number	20197	X16	P
Lines				
LN_DRWGN	Drawing number	A3256	X8	CD
LN_LENGT	Line length	100	I	CD
LN_MAKE	Line manufacturer	ABCAL	X16	CD
LN_SIZE	Size,cross-section	0.25"	X8	CD
LN_TYPE	Type,material	AL	X8	CD
LN_YEAR	Year of installation	1968	I	CD
Low voltage panels				
LV_AMPS	Amp rating of circuit	300	I	S
LV_CIRCT	Circuit name	CSB NE Cook ST	X48	S
LV_CTNO	LV panel Circuit number	6	I	S
LV_DESC	LV Panel description	6 Circuit 800A	X20	S
LV_ISOLT	Isolation type	Ceram	X8	S
LV_LIGHT	Street lighting connected(y/n)	Y	X	S
LV_NUMBR	Unique low voltage panel number	203	I	S
LV_PANEL	Panel type	Marble	X8	S
LV_SWITH	Switch type	DL2	X8	S
Nodes				
N_NAME	Node name(unique within substation)	HV Switchgear	X32	P
N_TYPE	Node type(eg SG LV Panel etc)	Switchgear	X16	P
N_VOLT	Node voltage	11000	F	P

Item name	Description	Example	Format	Owner
Oil Switches				
OS_BUSAM	Busbar amps	1200	I	SD
OS_DATE	Purchase date	12/12/79	2I	S
OS_DESLB	Destination label	Berry St.	X64	S
OS_DESND	Destination node for outgoing cable	HV Switchgear	X32	P
OS_DESUB	Destination sub for outgoing cable	English St. Sub	X32	P
OS_DLAYT	Drawing numbers(MED):layout	A0003	2X8	SD
OS_DMLYT	Drawing numbers(Maker):layout	AM456	2X8	S
OS_DMWG	Drawing numbers(Maker):wiring	AM362	2X8	S
OS_DWIRG	Drawing numbers(MED):wiring	AM498	2X8	SD
OS_MAKE	Manufacturer	South Wales	X16	S
OS_MVA	MVA size	350	I	S
OS_NSEQ	Whether OS's node location is top or bottom of the branch including OS.	Top	X6	P
OS_ORDER	Order(contract) number	490	I	S
OS_PANEL	OS panel number	15	I	S
OS_PRICE	Price	1200	F	S
OS_REMRK	General remarks	Repaired 12/82	X32	S
OS_SERNO	Serial number	E07124	X16	S
OS_SPEC	Spec number	1203	I	S
OS_TYPE	Switchgear type(model variety)	D6X4	X8	S
OS_VOLT	Voltage	11000	F	S
Pilot cable pairs				
P_DESGNT	Designation	T2-C	X8	W
P_JUMPER	Jumper to other pairs	17A-17B	X8	W
P_NUMBER	Pair number within box	15	I	W
Pilot cable boxes				
PB_LOCAT	Physical location	South wall	X16	W
PB_NUMBR	Pilot box number within substation	2	I	W
PB_TYPE	Pilot box type	8 core 24 pair	X32	W
Pilot cables				
PC_MAKE	Cable manufacturer	GEC	X16	W
PC_NUMBR	Unique pilot cable number	102	I	W
PC_SIZE	Cross-section	.04	F	W
PC_TYPE	Material	AL	X8	W

Item name	Description	Example	Format	Owner
Relays				
R_CTS	Relay CTs	100-400/1	X16	T
R_EL	Earth leakage	4	I	T
R_FUNCT	Function/Purpose	Earth fault	X16	T
R_IDATE	Issue date	01 08 1965	2I	T
R_MAKE	Manufacturer	ASEA	X16	T
R_MEDNO	MED number	547	I	T
R_OC	Overcurrents	.75 .2	X16	T
R_PHASE	Phase	3	I	T
R_RANGES	Ranges	+6 sec 2.5-10A	X16	T
R_RATING	Relay rating(amps)	6	I	T
R_RDATE	Return date	01 09 1960	2I	T
R_REMARK	Comments	out of service	X32	T
R_REMDAT	Remarks date	01 12 1974	2I	T
R_SERNO	Serial number	8385/10	X16	T
Relay types				
RT_DESGN	Relay type designation	Imped. different.	X32	T
RT_TYPE	Relay type	R1	X8	T
Rounds				S
RO_NUMBR	Round number	23	I	S
RO_SEQ	Sequence within round	3	I	S

Item name	Description	Example	Format	Owner
Substations				
S_BATTRY	Battery(y/n)	Y	X	S
S_BATVOL	Battery voltage	12	I	S
S_BUILDG	Building drawing number	B1067	X8	D
S_CHARGE	Battery charger(y/n)	Y	X	S
S_CHECK	Checking dates	1/75 3/79 4/82	6I	D
S_COLOUR	Colour	Brown	X8	D
S_DATE	Building date	3/68	I	D
S_DIMEN	Dimensions	65.4 35.2	2F	D
S_DOORS	Door type	Timber	X8	D
S_DRWGNO	Other drawing number	A32	X8	SD
S_EXPANT	Exterior painting dates	2/79 3/81	6I	D
S_FSIZE	Fuse size	32	I	S
S_FTYPE	Fuse type	Powder	X16	S
S_FUSE	Fuse isolator(y/n)	Y	X	S
S_GRAFF	Graffiti dates	3/81 4/83	6I	D
S_GRID	Grid coordinates	08A4	X4	D
S_GUTTER	Guttering material/location	Cu Int.	X8	D
S_INPANT	Interior painting dates	3/68 4/69 5/69	6I	D
S_LOCATN	Physical location	South side	X32	S
S_PASTYL	Painting style	Spray	X8	D
S_PATYPE	Painting type	Anti-graffiti	X16	D
S_PIPES	Pipe material/location	Cu Extl.	X8	D
S_REMARK	General comments	Graffiti Victim	X32	S
S_ROOF	Roof material	Conc	X4	D
S_SILIC	Siliconing dates	2/74 3/81 2/82	6I	D
S_SITE	Site drawing number	D2093	X8	D
S_SWGEAR	Switchgear plan number	SW2036	X8	D
S_TYPE	Substation type	Low kiosk	X12	S
S_WALLS	Wall material	Block	X6	S

Item name	Description	Example	Format	Owner
Transformers				
T_BLUE	Blue current reading	600	4I	SP
T_CONDRG	Configuration drawing number	A3267	X8	S
T_CONFIG	Configuration description	Lh cable box...	X32	S
T_CONSER	Conservator(y/n)	Y	X	S
T_DATE	Date of purchase	12/12/81	2I	S
T_EXTTAP	External taps(%)	2.50 -2.50 .5	4I	S
T_IMPED	Impedance(%)	4.24	I	SP
T_KVA	KVA rating	300	I	SP
T_LOCAT	Physical location inside substation	SW corner	X16	S
T_LOSSES	Cu/Fe losses	10	I	S
T_MAKE	Manufacturer	Tyree Power Con	X16	S
T_MULT	MDI mult	300	I	S
T_NAME	Transformer name unique within substation	EG. T1	X16	S
T_OILVOL	Oil volume	488	I	S
T_OLR	Overload rating	5	I	SP
T_ORDER	Order number	205	I	S
T_PHASE	Phase	3	I	S
T_PRICE	Purchase price	23679	F	S
T_RATIO	Ratio	11000 415	2I	S
T_RED	Red current rating	300	4I	SP
T_REMARK	General transformer remarks	Under repair	X32	S
T_SERIAL	Serial number	AD12036	X16	S
T_SPEC	Spec number	635	I	S
T_TAPS	Tap settings	210 220 230	6I	S
T_THEROM	Thermometer(y/n)	Y	X	S
T_TYPE	Transformer type	HV Consumer	X16	SP
T_WEIGHT	Weight	1555	I	S
T_YELLOW	Yellow current rating	1200	4I	SP
Voltage transformers				
VT_BRDN	Burden	Class B	X8	S
VT_COST	Purchase cost/price	1206.58	F	S
VT_DATE	Purchase date	12/12/81	2I	S
VT_MAKE	Manufacturer	GEC	X16	S
VT_ORDER	Order number	230	I	S
VT_PHASE	Phase	3	I	S
VT_PROT	Protection status(y/n)	Y	X	S
VT_RATIO	Ratio	11000/415	2I	S
VT_REMRK	Remarks,general comments	In service	X32	S
VT_SERNO	Serial number	AD12056	X16	S
VT_SPEC	Spec number	201	I	S
VT_TYPE	Transformer model type	DA11	X8	S

Item name	Description	Example	Format	Owner
WIS, Work Instruction Sheets				
WIS_CABL	Status of cables involvement in work	Completed	X16	PC
WIS_CDAT	Completion date	12/12 1969	2I	P
WIS_DES	WIS description	U/G LV reticul..	X48	P
WIS_IDAT	Issue date	12/12 1968	2I	P
WIS_INIT	Initiative from(person)	CAA	X4	P
WIS_JNTG	Status of jointing	Not interested	X16	PC
WIS_LIVD	Live status of cable/line	Dead	X4	PC
WIS_NO	Unique number	2104	I	P
WIS_OTHR	Status of other involvement in work	None	3X32	P
WIS_PPMP	Planning photo map numbers	A39 B67	6X3	P
WIS_PRTY	Work priority	5	I	P
WIS_REMK	General remarks	Urgent work	X32	P
WIS_SUBS	Status of subs involvement in work	Not involved	X16	PS
WIS_WCOM	Works completed status	Uncompleted	X16	P
WIS_WDRG	Working drawing numbers	WD2325	6I	PD

APPENDIX (III)

DATA ANALYSIS DOCUMENT.

In all developed relations the primary key is underlined.

Data analysis details are included in two parts
(1) the initially developed relations with full explanation,
(2) a summary of relations with duplicates removed and combinations made.

Arrows.

```
A <--------->  B : a one to one correspondence between A and B.
A <--------->> B : a one to many correspondence between A and B,
                    each A corresponds to many Bs,
                    each B corresponds to one A.
A  --------->  B : a restricted one to one correspondence between
                    A and B, each A corresponds to one B but
                    each B does not always correspond to one A.
                   There must always be equal or more Bs than As.
```

LAND

Key   L-MEDNAM * L-VALUE

MED land may have no MED name and if so it is uniquely identified by valuation role number. Land can have a MED name but no valuation role number. Usually a piece of land has both a MED name and a valuation role number, but where one is missing the other is present for unique land identification. Therefore a unique key for a piece of MED land is achieved through the combination of L-MEDNAM and L-VALUE.

(1) Land relationship

L-MEDNAM * L-VALUE <----> L-ADATE, L-ADDRSS, L-BODY, L-COT, L-EXDATE, L-GRIDNO, L-LDESCP, L-PONAME, L-REMARK, L-SITE, L-TENURE

For a particular piece of land identified by MED name and valuation role number, there is only one agreement date, address, local body etc.

WORK INSTRUCTION SHEETS

Key: WIS-NO, work instruction sheet number.

Relationships

(2) General WIS information

WIS-NO <----> WIS-CABL, WIS-CDAT, WIS-DES, WIS-IDAT, WIS-INIT, WIS-UNTG, WIS-LIVD, WIS-OTHR, WIS-PPMP, WIS-PRTY, WIS-REMK, WIS-SUBS, WIS-WCOM, WIS-WDRG

(3) Many substations are involved in one WIS, one substation has many WIS'S involving it.

WIS-NO <<--->> L-MEDNAM

(2) is in 3rd Normal Form, (3) is not.

(3) becomes WIS-NO * L-MEDNAM

SUBSTATION ROUNDS

Relationship

(6) RO-NUMBER * RO-SEQ <-----> L-MEDNAM, T-NAME, T-KVA,
T-TYPE, T-MULT, S-TYPE

For a particular round and sequence within the round, there is one transformer inside a particular substation. Relation is not in third normal form as there is transitive dependency between non-key data elements, namely

Relations

(4) L-MEDNAM <-----> S-TYPE

(5) T-NAME * <-----> T-KVA, T-TYPE, T-MULT
L-MEDNAM

(6) Becomes

RO-NUMBER * RO-SEQ <-----> L-MEDNAM, T-NAME

SUBSTATIONS

Key: L-MEDNAM, each substation has a unique MED name, this name is also used to identify MED land sites. Each substation has a wealth of information belonging to it.

Relationship

(7) L-MEDNAM <-----> S-BATTRY, S-BATVOL, S-BUILDG, S-CHARGE,
S-CHECK, S-COLOUR, S-DATE, S-DIMEN,
S-DOORS, S-DRWGNO, S-EXPANT, S-FSIZE,
S-FTYPE, S-FUSE, S-GRAFF, S-GRID,
S-GUTTER, S-INPANT, S-LOCATN, S-PASTYL,
S-PATYPE, S-PIPES, S-REMARK, S-ROOF,
S-ILIC, S-SITE, S-SWGEAR, S-TYPE,
S-WALLS

TRANSFORMERS INFORMATION

Transformers are purchased in groups at a time. Each group of transformers purchased can be identified by order #, specifications # and kVA rating. Many data elements are the same for all transformers within a particular group. Hence relationship (8):

(8) T-ORDER * T-SPEC * T-KVA <-----> T-OILVOL, T-WEIGHT,
T-IMPED, T-LOSSES,
T-PHASE, T-RATIO,
T-TAPS, T-CONFIG,
T-MAKE

Individual transformers can be uniquely identified by substation location combined with their transformer name within the substation.

```
(9)     L-MEDNAM * T-NAME <----> T-ORDER, T-SPEC, T-KVA
                                 T-BLUE, T-CONDRG,
                                 T-CONSER, T-DATE,
                                 T-EXTTAP,T-LOCAT,
                                 T-OLR, T-PRICE,
                                 T-RED, T-REMARK,
                                 T-THEROM, T-TYPE,
                                 T-MULT, T-YELLOW,
                                 T-SERIAL
```

VOLTAGE TRANSFORMERS

Voltage transformers are purchased many at a time. Each purchase group of voltage transformers have similar characteristics.

Group relatioship:

```
(10)    VT-ORDER * VT-SPEC * VT-BRDN <----> VT-RATIO, VT-PHASE
```

Main access to voltage transformers is by Manufacturer. Manufacturer and serial number uniquely identify each individual voltage transformer.

```
(11)    VT-MAKE * VT-SERNO <----> VT-COST, VT-DATE, VT-PROT,
                                  VT-REMRK, VT-TYPE, VT-ORDER,
                                  VT-SPEC, VT-BRDN
```

Each voltage transformer is also associated with a certain circuit breaker, within a certain switchgear room (NODE) inside a certain substation.

```
(12)    VT-MAKE * VT-SERNO <----> CB-PANEL, N-NAME, L-MEDNAM
```

Certain voltage transformers are only compatible (physical interface) with certain circuit breakers models. Only certain voltage transformers can be installed on a particular circuit breaker model. A relationship exists between voltage transformer purchase groups and circuit breaker purchase groups.

```
(13)    VT-ORDER * VT-SPEC * VT-BRDN <<---->> CB-SPEC

        (13) in 3rd normal form, removing <<---->> relation.

(13)    VT-ORDER * VT-SPEC * VT-BRDN * CB-SPEC
```

CIRCUIT BREAKERS

Circuit breakers are generally purchased in groups. Each purchase group of circuit breakers meet certain specifications, therefore circuit breakers within a group have many similar characteristics (such as manufacturer etc.).

Group relationship:

(14) CB-SPEC <----> CB-CLOSG, CB-CPWR, CB-DATE, CB-DLAYT, CB-DMLYT, CB-DMWG, CB-DWIRG, CB-EARTH, CB-VOLT, CB-MVA, CB-ORDER, CB-POWER, CB-TRIPG, CB-WONO, CB-MAKE, CB-TYPE, CB-UAMPS

Circuit breaker specification number identifies a purchase group of circuit breakers. All circuit breakers in that group have the same closing type, closing power, purchase date etc.

A series of adjacent circuit breakers are electrically linked via connections to a common busbar. A series of circuit breakers is installed in a "switchgear room", within a substation. Large substations contain many switchgear rooms.

Some of the smaller substations contain only one series of circuit breakers. The substation is itself effectively a "switchgear room".

A "switchgear room" is a point in the network where branching takes place. Therefore a switchgear room is a network node. Individual circuit breakers are identified by (1) Panel number, within a (2) switchgear room or node within a (3) substation.

Individual circuit breaker information:

(15) L-MEDNAM * N-NAME * CB-PANEL <----> CB-BUSAM, CB-SPEC, CB-DESLB, CB-EARTH, CB-LOCKD, CB-OPEN, CB-POSIT, CB-REMRK, CB-SERNO, CB-TAG, CB-TAGNAM, CB-PRICE,

AUXILIARY TRANSFORMERS

Auxiliary Transformers are purchased in groups. Each purchase group of Auxiliary Transformers meet certain specifications. Therefore there are common characteristics for all transformers within a group.

Group relationship:

(16) AT-ORDER * AT-SPEC * AT-KVA <----> AT-PHASE, AT-RATIO

Individual Auxiliary transformers are uniquely identified by make and serial number.

(17) AT-MAKE * AT-SERNO <----> AT-ORDER, AT-SPEC, AT-KVA, AT-COST, AT-PURP, AT-REMRK, AT-TYPE, AT-DATE

Each auxiliary transformer is installed with a circuit breaker. A circuit breaker is identified by panel, switchgear room (node) and substation.

AT-CB relation

(18) AT-MAKE * AT-SERNO <----> CB-PANEL, N-NAME, L-MEDNAM

Only certain auxiliary transformer are physically compatible with certain circuit breaker models. A "compatibility relationship" exists between auxiliary transformer purchase groups and circuit breaker purchase groups.

(19) AT-ORDER * AT-SPEC * AT-KVA <<---->> CB-SPEC

(19) in 3rd normal form, removing <<---->> relation

(19) AT-ORDER * AT-SPEC * AT-KVA * CB-SPEC

OIL SWITCHES

Purchase groups of oil switches are identified by specifications number. All oil switches within a purchase group have several identical data items.

Group relationship:

(20) OS-SPEC <----> OS-DATE, OS-DLAYT, OS-DMLYT, OS-DMWG, OS-DWIRG, OS-MAKE, OS-MVA, OS-ORDER, OS-PRICE, OS-TYPE, OS-VOLT, OS-WONO

A series of circuit breakers, fuse switches, oil switches are all electrically linked via a common busbar. An adjacent row of CB's, FS's, OS's are installed within substation switchgear rooms.

A "switchgear" room is where most network branching takes place. A "switchgear" room is a network node. Individual oil switches are identified by their location substation node (switchgear room) and panel number.

Individual oil switch information.

(21) L-MEDNAM * N-NAME * OS-PANEL <----> OS-SPEC, OS-REMRK, OS-DESLB, OS-BUSAM, OS-SERNO

FUSE SWITCHES

Purchase groups of fuse switches are identified by specifications number. All fuse switches within a purchase group have several identical data items.

Group relationship:

(22) FS-SPEC <-----> FS-DATE, FS-DLAYT, FS-DMLYT, FS-DMWG, FS-DWIRG, FS-MAKE, FS-MVA, FS-ORDER, FS-PRICE, FS-TYPE, FS-VOLT, FS-WONO

Individual fuse switch information relation, same relational characteristics as for oil switches.

(23) L-MEDNAM * N-NAME * FS-PANEL <-----> FS-SPEC, FS-REMRK, FS-DESLB, FS-BUSAM, FS-SERNO

ISOLATORS, SECTIONALIZERS, RECLOSERS

Isolators, sectionalizers and reclosers are simple network circuit elements. These elements have been given numbers in the past for unique identification.

Individual isolator, sectionalizer, recloser information.

(24) I-NUMBER <-----> I-INITAL, I-OPEN, I-LABEL, I-LOCKED, I-MAKE, I-TAGGED, I-TAGNAM, I-TYPE, I-YEAR

LOW VOLTAGE PANELS

Low voltage panels are the extreme outer nodes of the network. From low voltage panels cables run down streets and eventually to consumers. Low voltage panels and the 66 kV feeders into district substations form the bounds of this database. Individual low voltage panels are identified by low voltage panel numbers in this database. Unique panel identification independent of panel location doesn't at present exist.

Individual L.V. Panel information.

(25) LV-NUMBER <-----> LV-TYPE, LV-DESC

Each low voltage panel has a variable number of outgoing cables. Each outgoing circuit is identified by circuit number within a low voltage panel.

L.V. outgoing circuit. Low voltage Panel <---->> Circuits

(26) LV-NUMBER * LV-CTNO <-----> LV-AMPS, LV-CIRCT, LV-ISOLT, LV-LIGHT, LV-SWITH

ALL INSULATED UNITS

AIU's with common specifications are purchased in groups at a time. Groups of AIU's are identified by order (contract) number.

Group AIU information:

(27) AIU-ORDR <----> AIU-VARY,
AIU-TYPE, AIU-MVA,
AIU-RATG, AIU-DATE,
AIU-PRCE, AIU-VOLT

Individual AIU's are uniquely identified by make and serial number.

Individual AIU information:

(28) AIU-MAKE * AIU-SERN <----> AIU-ORDR, AIU-CNFG, AIU-STAT,
AIU-AMPS, AIU-REMK

An AIU consists of several 'units', each unit linking the AIU with a different location. Effectively an AIU has many 'branches' via it's units. Individual AIU units are identified by their unit number within an AIU.

Individual AIU, unit information:

AIU <---->> units

(29) AIU-MAKE * AIU-SERN * AIU-UNIT <----> AIU-DLAB

LINES

At present most information concerning lines is recorded on maps. This database design creates a unique line number for each line element in the network. Each length of line, which is a network element is uniquely identified by its line number.

Line information:

(30) LN-NUMBER <----> LN-DRWGN, LN-LENGT, LN-MAKE,
LN-SIZE, LN-TYPE, LN-YEAR

CABLES

Laid cables are presently not recorded on an individual basis. The drawing office lists on a individual card all cable lengths and joints involved in linking two substations together. This database design specifies a unique cable number for each cable element in the network. An individual cable length-which is a network element, is identified by its cable number.

Cable information:

(31) C-NUMBER <----> C-LENGTH, C-MAKE, C-SIZE,
C-TYPE, C-UGSHT, C-YEAR, B-INDEX

RELAYS

Individual relay units are identified by make, relay type and serial number.

Individual relay information:

(32) R-MAKE * RT-TYPE * R-SERNO <----> R-RATING, R-MEDNO,
R-RANGES, R-IDATE,
R-PHASE, R-RDATE,
R-OC, RT-DESGN,
R-CTS, R-EL,
R-FUNCT, R-REMARK,
R-REMDAT

Relation (32) is not in 3rd normal form as there is partial dependence of a non-key item on the key items. Relay type designation (RT-DESGN) only depends on RT-TYPE.

Two new relations:

(32) R-MAKE * RT-TYPE * R-SERNO <----> R-RATING, R-MEDNO,
R-RANGES, R-IDATE,
R-PHASE, R-RDATE,
R-OC, R-CTS, R-EL,
R-FUNCT, R-REMARK,
R-REMDAT

(33) RT-TYPE <----> RT-DESGN

Relays are installed on individual circuit breakers. Therefore a relation exists between individual relays and individual circuit breakers.

Relays and CB's:

(34) R-MAKE * RT-TYPE * R-SERNO <---->

L-MEDNAM, N-NAME, CB-PANEL

PILOT CABLE BOXES

Substations can have many pilot cable boxes. A pilot cable box is uniquely located by substation and pilot box number within that substation.

(35) L-MEDNAM * PB-NUMBR <----> PB-LOCATN, PB-TYPE

PILOT CABLE CIRCUITS

Many pilot cable circuits exist in the network, each with it's own purpose. A simple circuit number identifies each circuit.

(36) CR-NUMBR <----> CR-PURPS

PILOT CABLE PAIRS

A cable linked to a Pilot Cable Box contains many pairs. Each pair within a cable is linked to a terminal within the pilot box. Each terminal is identified as pair number. Unique pair identification is a combination of substation, pilot box, pilot cable and pair number.

Individual pair information:

(37) L-MEDNAM * PB-NUMBR * PC-NUMBR * P-NUMBR

<----> P-DESGNT, P-JUMPER

PILOT CABLES

Each pilot box contains many incoming pilot cables. Each pilot cable links two pilot boxes. Thus there is a many to many relationship between pilot boxes and pilot cables.

(38) L-MEDNAM * PB-NUMBR <<---->> PC-NUMBR

Not in 3rd normal form, (38) in 3rd normal form:

(38) L-MEDNAM * PB-NUMBR * PC-NUMBR

Pilot cables are uniquely identified by pilot cable number.

Individual pilot cable information:

(39) PC-NUMBR <----> PC-MAKE, PC-SIZE, PC-TYPE

PILOT CABLE CIRCUITS

A pilot cable circuit consists of many links of pairs between different substations. A series of linked pilot pairs via pilot cables running between various substations form a pilot cable circuit.

Pilot cable circuit (pairs):

(40) CR-NUMBER <---->> L-MEDNAM * PB-NUMBER *
PC-NUMBR * P-NUMBER

One pilot cable circuit consists of many pairs.

(40) in 3rd normal form

CR-NUMBR * L-MEDNAM * PB-NUMBR * PC-NUMBR * P-NUMBER

NODES

Most network nodes are situated inside substations. A substation can contain many nodes such as low voltage panels, magnefix units and switchgear rooms. Unique node identification is achieved through substation name and node name within substation.

Substations and nodes:

substation <---->> nodes

(41) L-MEDNAM * N-NAME <----> N-TYPE, N-VOLT

However not all network nodes are situated inside substations, e.g. 'T' joints and 4-way joints. To maintain the relation an 'artificial substation' will be created, e.g. 'Tee Joints' and each tee joint within that artificial substation will be uniquely identified by N-NAME. N-NAME for a tee joint will be a description of the three branches that it joints e.g. "Joyce St, Peer St, Jolly St".

Each AIU is considered a network node. Therefore a relation between AIUs and nodes exists:

(42) AIU-MAKE * AIU-SERN ----> L-MEDNAM, N-NAME

Each AIU is a network node, but each network node is not always an AIU.

Similarly each L.V. Panel is also a network node.

(43) LV-NUMBR ----> L-MEDNAM, N-NAME

Each LV panel is a network node, but each network node is not always a low voltage panel.

BRANCHES

Each network branch links two network nodes. Unique branch identification is gained by specifying the two nodes it links.

(44) B-TOPSUB * B-TOPNOD * B-BOTSUB * B-BOTNOD <----> B-INDEX

Relation (44) also includes the many to many relation between nodes and branches. B-TOPSUB, B-BOTSUB are equivalent to L-MEDNAM, as are B-TOPNOD, B-BOTNOD equivalent to N-NAME.

BRANCH ELEMENTS

Each branch consists of many circuit elements. A circuit element is uniquely identified by its branch, and its sequence in that branch.

(45) B-TOPSUB * B-TOPNOD * B-BOTSUB * B-BUTNOD * E-SEQ

<----> E-INDSEQ, E-TYPE

Each line, cable, transformer, circuit breaker, oil switch, fuse switch, and isolator is a branch element. Therefore relations between these pieces of equipment and branch elements:

(46) LN-NUMBR ----> B-TOPSUB, B-TOPNOD, B-BOTSUB, B-BOTNOD, E-SEQ

Each line is a branch element, but each branch element is not always a line.

(47) C-NUMBER ----> B-TOPSUB, B-TOPNOD, B-BOTSUB, B-BOTNOD, E-SEQ

(48) L-MEDNAM * T-NAME ----> B-TOPSUB, B-TOPNOD, B-BOTSUB, B-BOTNOD, E-SEQ

(49) I-NUMBER ----> B-TOPSUB, B-TOPNOD, B-BOTSUB, B-BOTNOD, E-SEQ

Branch elements and CB's, OS's, FS:

Individual CB, OS, FS information is uniquely identified by the equipment's location (substation, node and panel). This key is actually one half of the corresponding branch element key for the CB, OS or FS. So for the relation between individual CB, OS and FS and branch elements only the foreign node needs to be included for branch identification.

(50) L-MEDNAM * N-NAME * OS-PANEL

<----> B-TOPSUB, B-TOPNOD, B-BOTSUB, B-BOTNOD, E-SEQ

becomes

(50) L-MEDNAM * N-NAME * OS-PANEL

<----> OS-DESUB, OS-DESND, E-SEQ, OS-NSEQ

OS-NSEQ indicates whether OS node is top or bottom of branch.

(51) L-MEDNAM * N-NAME * CB-PANEL

<----> CB-DESUB, CB-DESND, E-SEQ, CB-NSEQ

(52) <u>L-MEDNAM</u> * <u>N-NAME</u> * <u>FS-PANEL</u>

<----> FS-DESUB, FS-DESND, E-SEQ, OS-NSEQ

Branch elements and AIU units.

A cable joined to a AIU is associated with a unit within the AIU. This unit is the first branch element of the linked branch.

(53) <u>AIU-MAKE</u> * <u>AIU-SERN</u> * <u>AIU-UNIT</u> <----> B-TOPSUB, B-TOPNOD, B-BOTSUB, B-BOTNOD, E-SEQ

APPENDIX (II) - CONTINUED

This is the final set of third normal form relations. Duplicate relations have been removed and relations with identical primary keys combined.

Each relation implemented in the demonstration database is denoted by the listing of its corresponding MIMER table name.

[I] (1) LAND MIMER table.

```
L_MEDNAM*L_VALUE <-----> L_ADATE ,L_ADDRSS,L_BODY  ,L_COT   ,L_EXDATE,
                         L_GRIDNO,L_DESCP ,L_PONAME,L_REMARK,L_SITE
                         L_TENURE
```

[II] (2) WIS MIMER table.

```
WIS_NO <------> WIS_CABL,WIS_CDAT,WIS_DES ,WIS_IDAT,WIS_INIT,WIS_JNTG,
                WIS_LIVD,WIS_OTHR,WIS_PPMP,WIS_PRTY,WIS_REMK,WIS_SUBS,
                WIS_WCOM,WIS_WDRG
```

[III] (3) WISSUB MIMER table.

```
WIS_NO*L_MEDNAM
```

(4) is a subset of (7), (5) is included in (9).

[IV] (6) ROUND MIMER table.

```
RO_NUMBR*RO_SEQ <------> L_MEDNAM,T_NAME
```

[V] (7) SUB MIMER table.

```
L_MEDNAM <----> S_BATTRY,S_BATVOL,S_BUILDG,S_CHARGE,S_CHECK ,S_COLOUR,
                S_DATE  ,S_DIMEN ,S_DOORS ,S_DRWGNO,S_EXPANT,S_FSIZE ,
                S_FUSE  ,S_GRAFF ,S_GRID  ,S_GUTTER,S_INPANT,S_LOCATN,
                S_PASTYL,S_PATYPE,S_PIPES ,S_REMARK,S_ROOF  ,S_SILIC ,
                S_SITE  ,S_SWGEAR,S_TYPE  ,S_WALLS ,S_FTYPE
```

[VI] (8)

```
T_ORDER*T_SPEC*T_KVA <----------> T_OILVOL,T_WEIGHT,T_IMPED ,T_LOSSES,
                                  T_PHASE ,T_RATIO ,T_TAPS  ,T_CONFIG,
                                  T_MAKE
```

[VII] Combination of (9) and (48) TRANSFMR MIMER table.

```
L_MEDNAM*T_NAME <------> T_ORDER ,T_SPEC  ,T_KVA   ,B_TOPSUB,B_BOTSUB,
                         B_TOPNOD,B_BOTNOD,T_BLUE  ,T_CONDRG,T_CONSER,
                         T_DATE  ,T_EXTTAP,T_LOCAT ,T_OLR   ,T_PRICE ,
                         T_RED   ,T_REMARK,T_THEROM,T_TYPE  ,T_MULT  ,
                         T_YELLOW,T_SERIAL ,E_SEQ
```

[VIII] (10)

```
VT_ORDER*VT_SPEC*VT_BRDN <-----> VT_RATIO,VT_PHASE
```

[IX] Combination of (11) and (12)

```
VT_MAKE*VT_SERNO <----> VT_COST ,VT_DATE ,VT_PROT ,VT_REMRK,VT_TYPE ,
                        VT_ORDER,VT_SPEC ,VT_BRDN ,L_MEDNAM,N_NAME  ,
                        CB_PANEL
```

[X] (13)

```
VT_ORDER*VT_SPEC*VT_BRDN*CB_SPEC
```

[XI] (14)

```
CB_SPEC <----> CB_CLOSG,CB_CPWR ,CB_DATE ,CB_DLAYT,CB_DMLYT,CB_DMWG ,
               CB_DWIRG,CB_EARTH,CB_VOLT ,CB_MVA  ,CB_ORDER,CB_POWER,
               CB_TRIPG,CB_WONO ,CB_MAKE ,CB_TYPE ,CB_UAMPS
```

[XII] Combination of (15) and (51) CB MIMER table.

```
L_MEDNAM*N_NAME*CB_PANEL <-----> CB_SPEC ,CB_DESUB,CB_DESND,CB_NSEQ ,
                                 E_SEQ   ,CB_BUSAM,CB_DESLB,CB_EARTH,
                                 CB_LOCKD,CB_OPEN ,CB_POSIT,CB_REMRK,
                                 CB_SERNO,CB_TAG  ,CB_TAGNM,CB_PRICE
```

[XIII] (16)

```
AT_ORDER*AT_SPEC*AT_BRDN <-----> AT_RATIO,AT_PHASE
```

[XIV] Combination of (17) and (18)

```
AT_MAKE*AT_SERNO <----> AT_COST ,AT_DATE ,AT_PURP ,AT_REMRK,AT_TYPE ,
                        AT_ORDER,AT_SPEC ,AT_KVA  ,L_MEDNAM,N_NAME  ,
                        CB_PANEL
```

[XV] (19)

```
AT_ORDER*AT_SPEC*AT_BRDN*CB_SPEC
```

[XVI] (20)

```
OS_SPEC <----> OS_DATE ,OS_DLAYT,OS_DMLYT,OS_DMWG ,OS_DWIRG,OS_MAKE ,
               OS_MVA  ,OS_ORDER,OS_PRICE,OS_VOLT ,OS_WONO ,OS_TYPE
```

[XVII] Combination of (21) and (50) OS MIMER table.

```
L_MEDNAM*N_NAME*OS_PANEL <-----> OS_SPEC ,OS_DESUB,OS_DESND,OS_NSEQ ,
                                 E_SEQ   ,OS_BUSAM,OS_DESLB,OS_SERN ,
                                 OS_REMRK
```

[XVIII] (22)

```
FS_SPEC <----> FS_CLOSG,FS_CPWR ,FS_DATE ,FS_DLAYT,FS_DMLYT,FS_DMWG ,
               FS_TRIPG,FS_WONO ,FS_MAKE ,FS_TYPE ,FS_UAMPS
```

[XIX] Combination of (23) and (52) FS MIMER table.

```
L_MEDNAM*N_NAME*FS_PANEL <-----> FS_SPEC ,FS_DESUB,FS_DESND,FS_NSEQ ,
                                 E_SEQ   ,FS_BUSAM,FS_DESLB,FS_EARTH,
                                 FS_REMRK
```

[XX] Combination of (24) and (49) ISOLATOR MIMER table.

```
I_NUMBER <---> B_TOPSUB,B_TOPNOD,B_BOTSUB,B_BOTNOD,E_SEQ   ,I_INITAL,
               I_OPEN  ,I_LABEL ,I_LOCKED,I_MAKE  ,I_TAGGED,I_TAGNAM,
               I_TYPE  ,I_YEAR
```

[XXI] Combination of (25) and (43) LVPANEL MIMER table.

```
LV_NUMBR <---> L_MEDNAM,N_NAME  ,LV_TYPE ,LV_DESC
```

[XXII] (26) LVCIRCT MIMER table.

```
LV_NUMBR*LV_CTNO <----> LV_AMPS ,LV_CIRCT,LV_ISOLT,LV_LIGHT,LV_SWITH
```

[XXIII] (27)

```
AIU_ORDR <---> AIU_VARY,AIU_TYPE,AIU_MVA ,AIU_VOLT,AIU_RATG,AIU_DATE,
               AIU_PRCE
```

[XXIV] Combination of (28) and (42) AIU MIMER table.

```
AIU_MAKE*AIU_SERN <---> AIU_ORDR,L_MEDNAM,N_NAME  ,AIU_CNFG,AIU_AMPS,
                        AIU_REMK
```

[XXV] Combination of (29) and (53) AIUUNIT MIMER table.

```
AIU_MAKE*AIU_SERN*AIU_UNIT <---> B_TOPSUB,B_TOPNOD,B_BOTSUB,B_BOTNOD,
                                 E_SEQ   ,AIU_DLAB
```

[XXVI] Combination of (30) and (46) LINE MIMER table.

```
LN_NUMBR <---> B_TOPSUB,B_TOPNOD,B_BOTSUB,B_BOTNOD,E_SEQ   ,LN_DRWGN,
               LN_LENGT,LN_MAKE ,LN_SIZE ,LN_TYPE ,LN_YEAR
```

[XXVII] Combination of (31) and (47) CABLE MIMER table.

```
C_NUMBER <---> B_TOPSUB,B_TOPNOD,B_BOTSUB,B_BOTNOD,E_SEQ   ,C_UGSHT ,
               C_LENGTH,C_MAKE  ,C_SIZE  ,C_TYPE  ,C_YEAR
```

[XXVIII] Combination of (32) and (34)

```
R_MAKE*RT_TYPE*R_SERNO <--------> L_MEDNAM,N_NAME  ,CB_PANEL,R_RATING,
                                  R_MEDNO ,R RANGES,R_IDATE ,R_PHASE ,
                                  R_RDATE ,R_OC    ,R_CTS   ,R_EL    ,
                                  R_FUNCT ,R_REMARK,R_REMDAT
```

[XXIX] (33)

```
RT_TYPE <----> RT_DESGN
```

[XXX] (35)

```
L_MEDNAM*PB_NUMBR <---> PB_LOCTN,PB_TYPE
```

[XXXI] (36)

```
CR_NUMBR <---> CR_PURPS
```

[XXXII] (37)

```
L_MEDNAM*PB_NUMBR*PC_NUMBR*P_NUMBR <----> P_DESGNT,P_JUMPER
```

[XXXIII] (38)

```
L_MEDNAM*PB_NUMBR*PC_NUMBR
```

[XXXIV] (39)

```
PC_NUMBR <---> PC_MAKE ,PC_SIZE ,PC_TYPE
```

[XXXV] (40)

```
CR_NUMBR*L_MEDNAM*PB_NUMBR*PC_NUMBR*P_NUMBR
```

[XXXVI] (41) NODE MIMER table.

```
L_MEDNAM*N_NAME <-----> N_TYPE  ,N_VOLT
```

[XXXVII] (44) BRANCH MIMER table.

B_TOPSUB*B_TOPNOD*B_BOTSUB*B_BOTNOD <---> B_INDEX

[XXXVIII] (45) ELEMENT MIMER table.

B_TOPSUB*B_TOPNOD*B_BOTSUB*B_BOTNOD*E_SEQ <------> E_INDSEQ,E_TYPE

APPENDIX (IV)

Key to the representation of the CONCEPTUAL MODEL.

A Relation.

Final third normal form relation number > V
Entity's name > Substation

Underlined data elements: key > L_MEDNAM
(not all non-key elements are listed.)

Arrows.

A <--------> B : a one to one correspondence between A and B.
A <-------->> B : a one to many correspondence between A and B, each A corresponds to many Bs, each B corresponds to one A.
A --------> B : a restricted one to one correspondence between A and B, each A corresponds to one B but each B does not always correspond to one A. There must always be equal or more Bs than As.

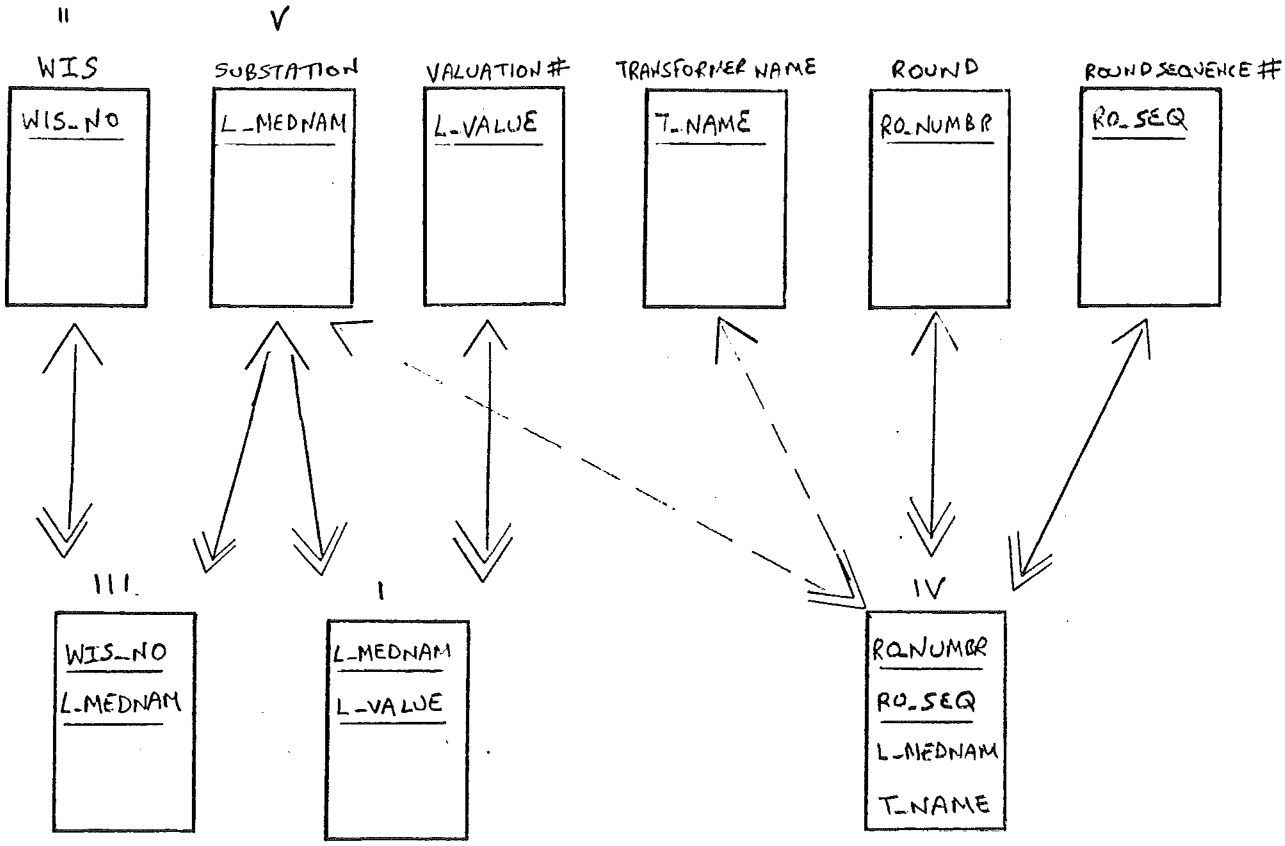
Solid arrows <---------------> display the relationships between relations with common key elements composing their primary keys.
Broken arrows <- - - - - - - - -> display the relationship between relations where a data element is part of the primary key in one relation and the same element is a non-key passive item in the other.
To provide linking between the various parts of the model spread on different pages, some relations are included on pages without their links to level one entity relations displayed. All relations are fully described showing all links to other relations at other levels, but where a relation is included on a page where it is not completely defined this is denoted by a diagonal strike through its representative box.

For example, XXXVI

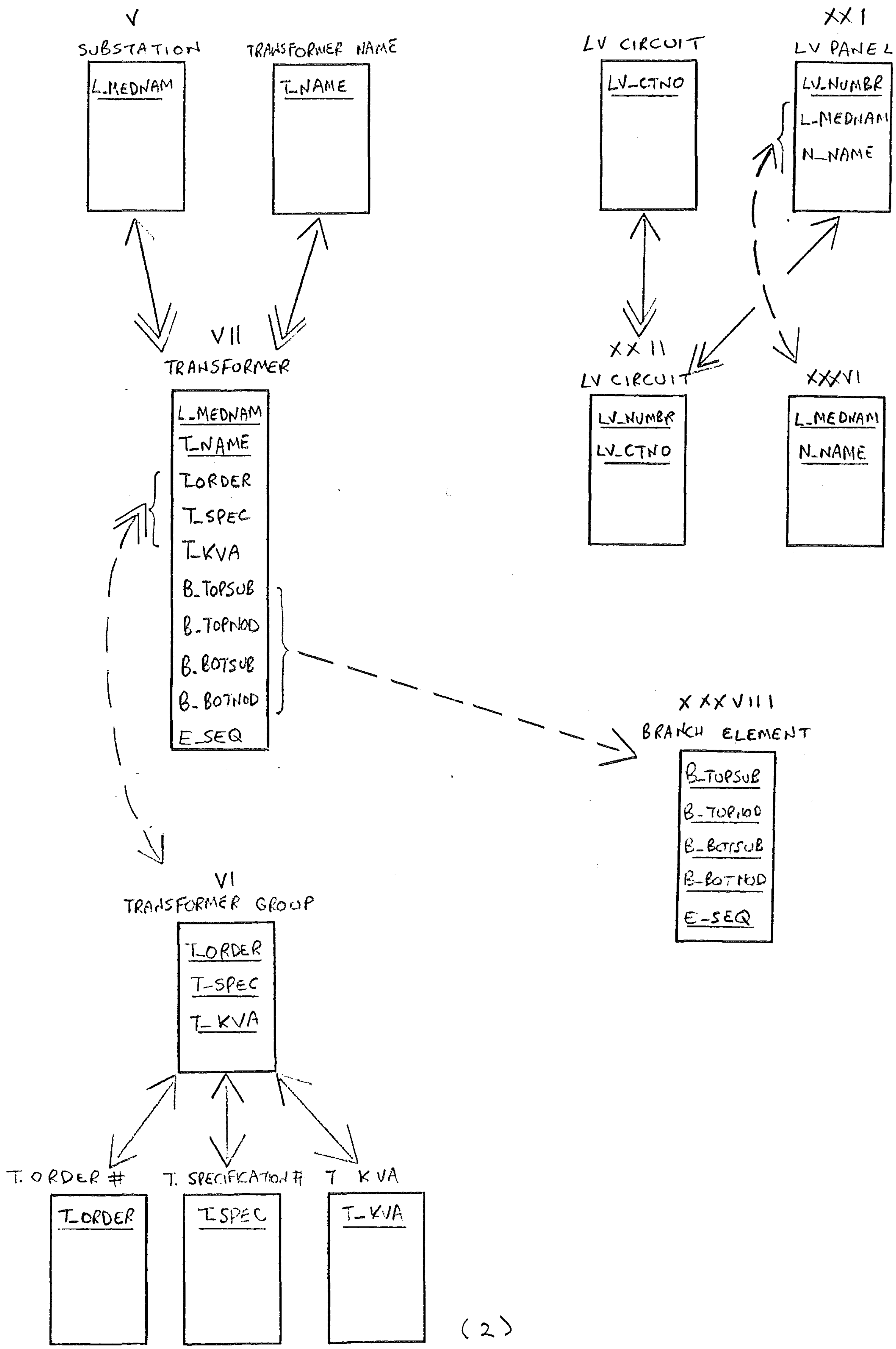
L_MEDNAM
N_NAME

This has been done to avoid excessive complication.

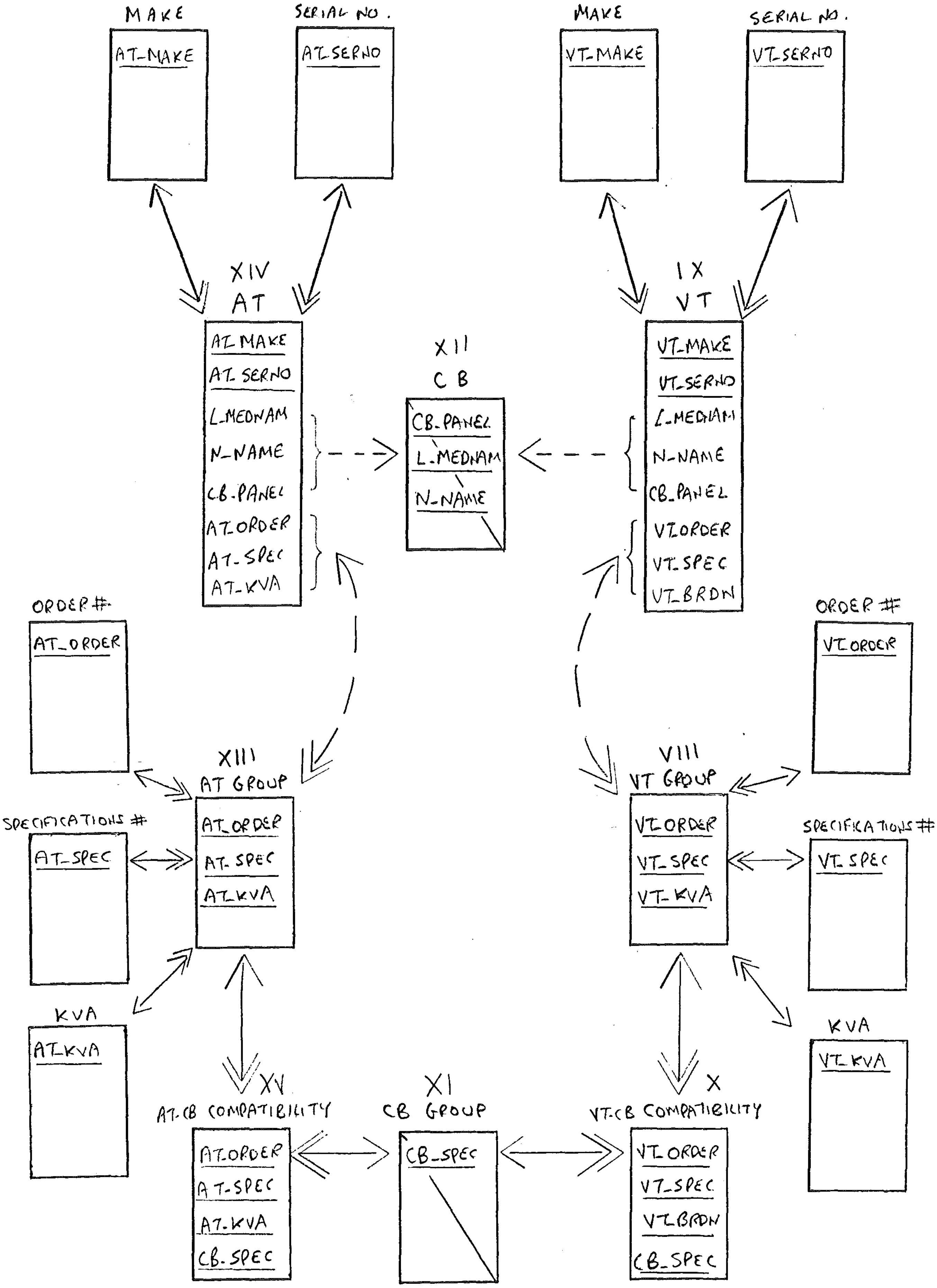
RELATIONS I to V



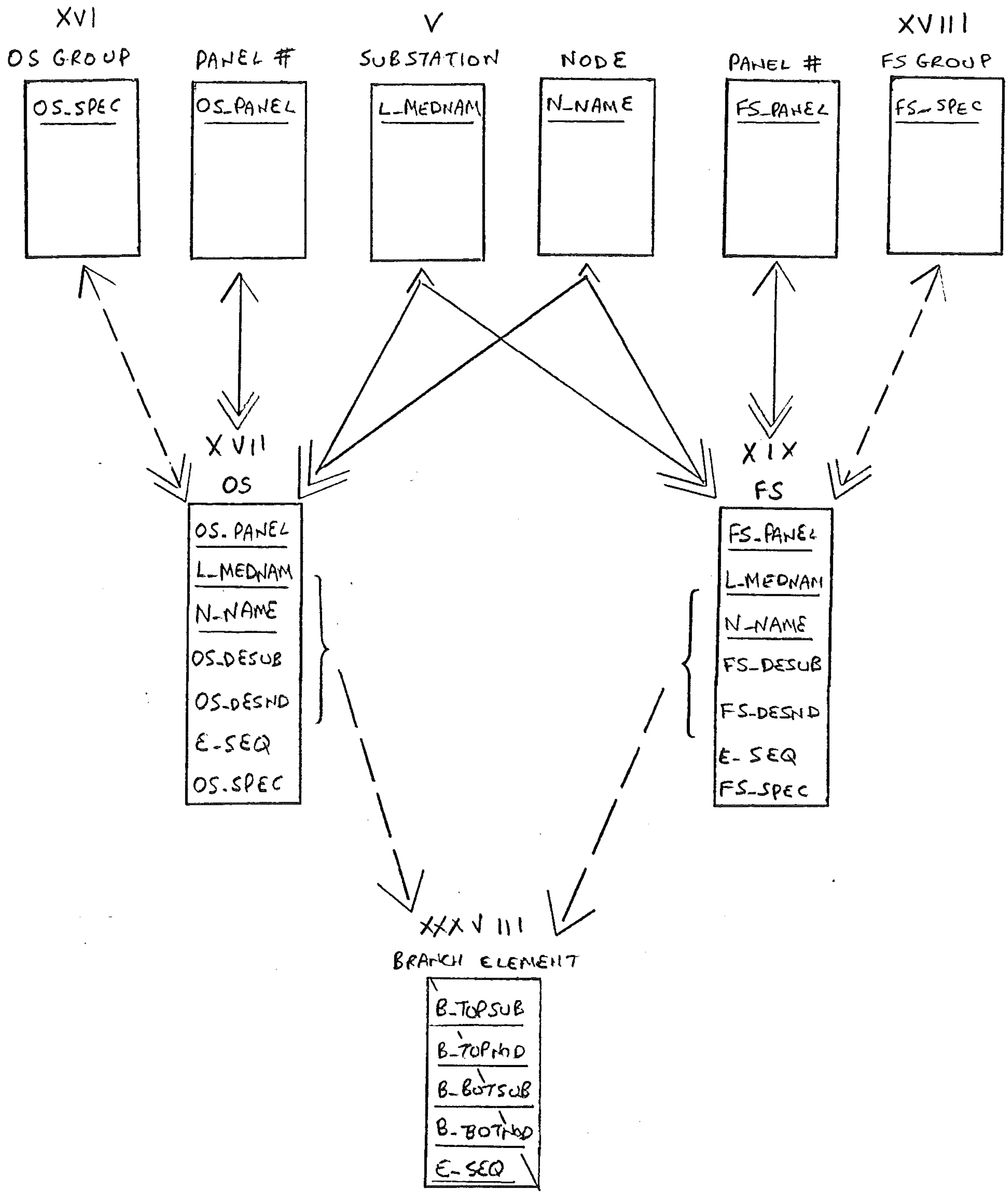
RELATIONS V, XXI, XXII, XXXVI, VII, VI



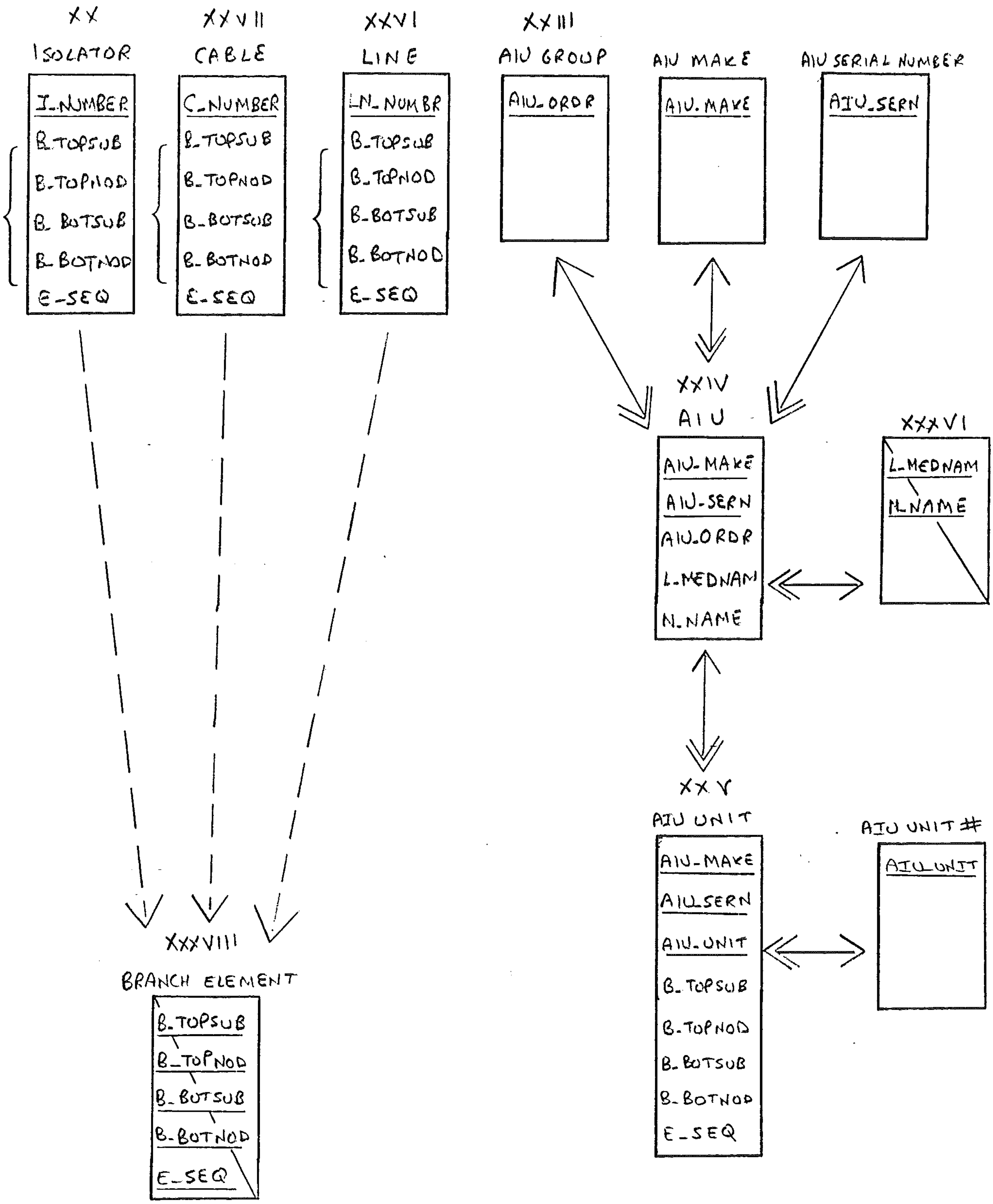
RELATIONS XI, XII, VIII, IX, X, XIII, XIV, XV



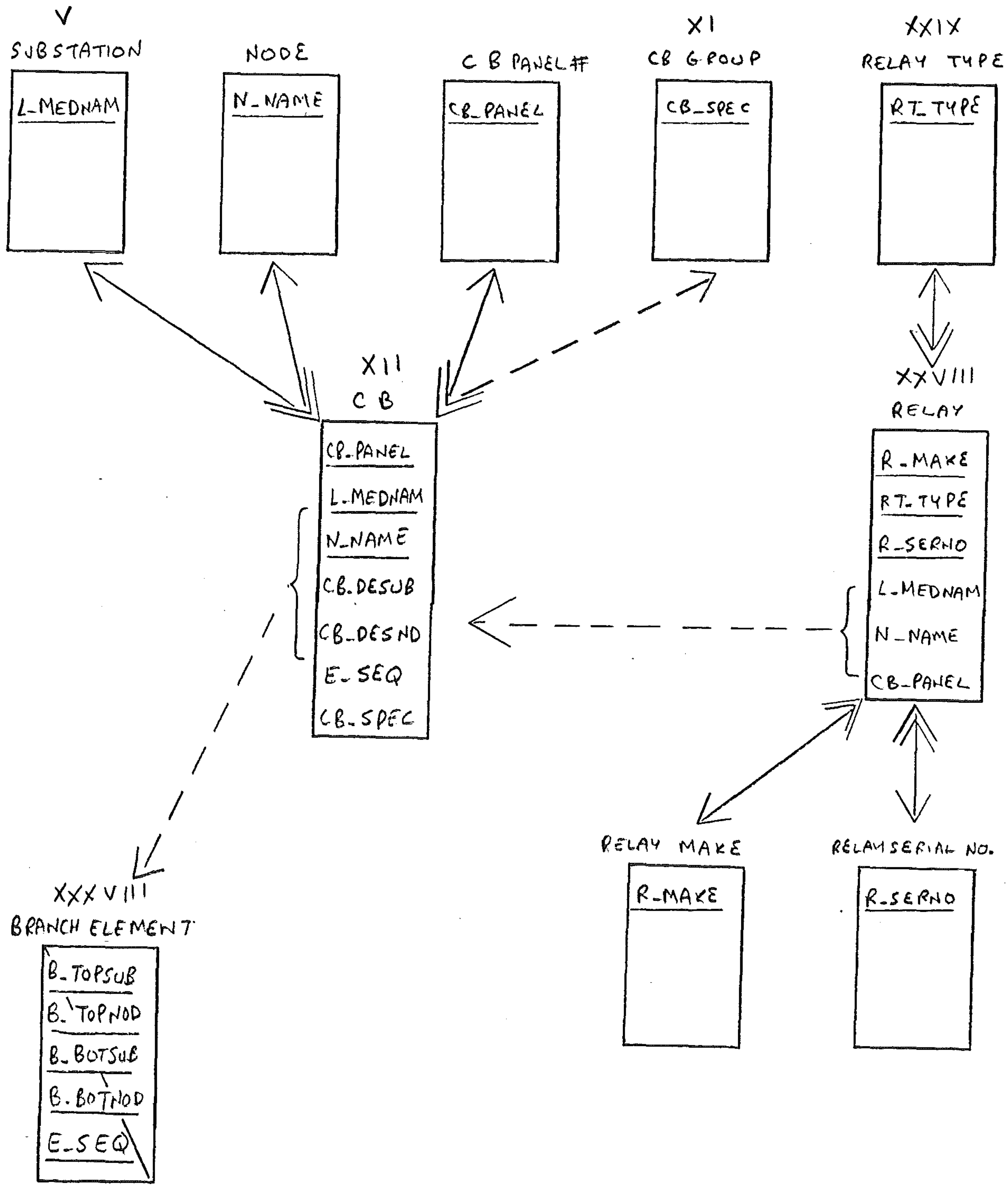
RELATIONS V, XVI, XVII, XVIII, XIX, XXXVIII



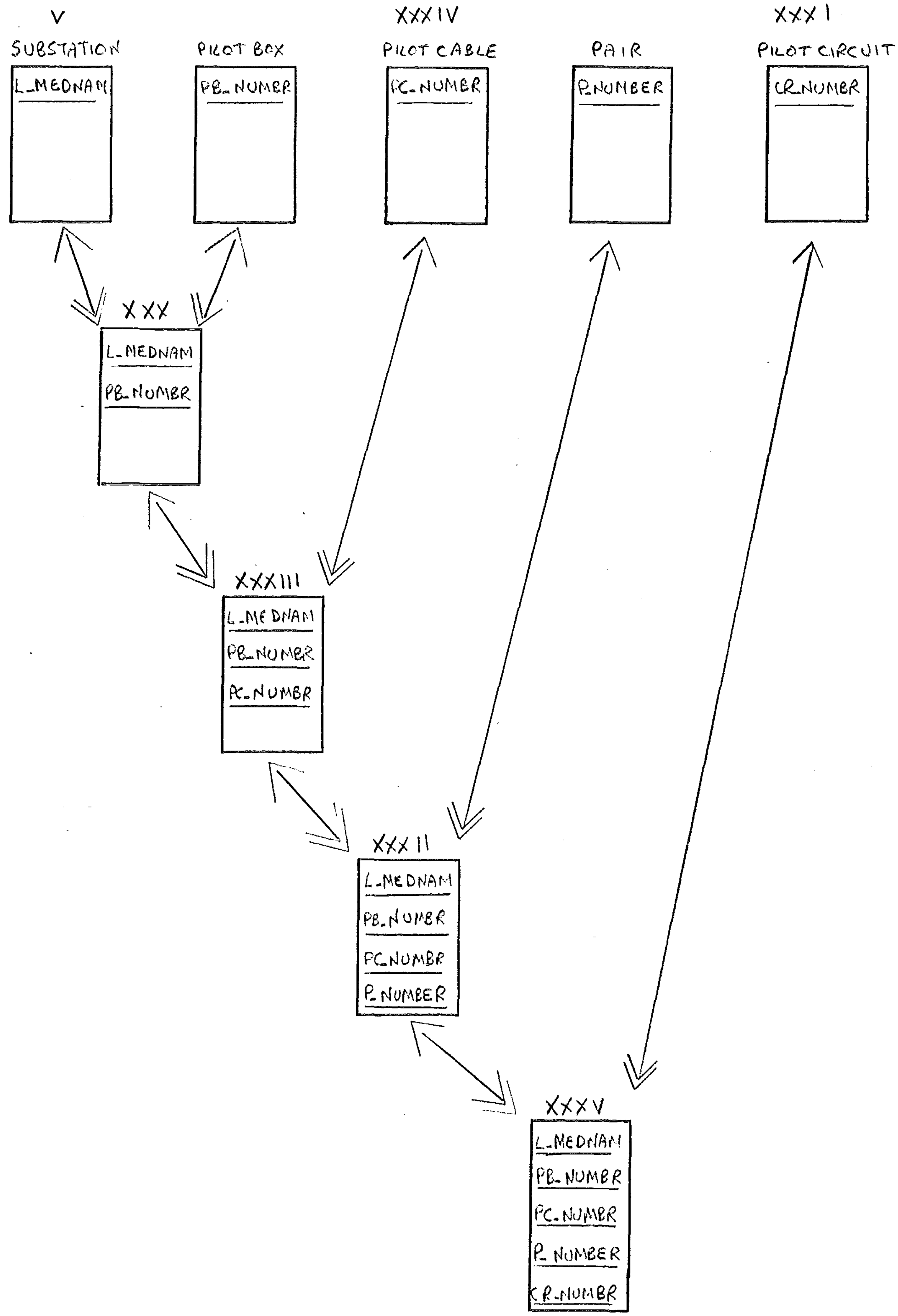
RELATIONS XX, XXVII, XXVI, XXIII, XXIV, XXV, XXXVI



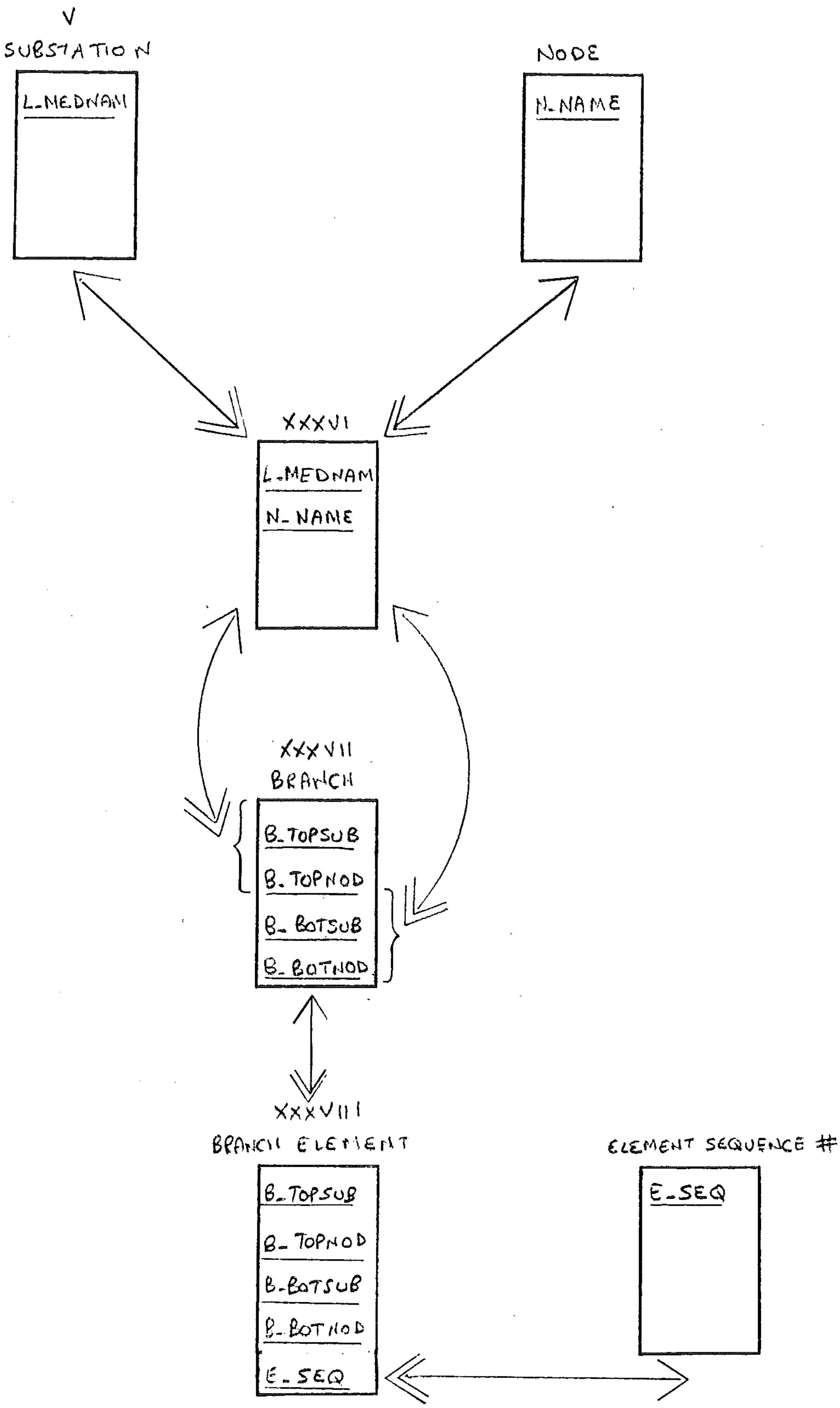
RELATIONS V, XI, XXIX, XXVIII, XII, XXXVIII



RELATIONS V, XXX to XXXV



RELATIONS V, XXXVI to XXXVIII



L_MEDNAM, B_TOPSUB, B_BOTSUB are all keys to the Substation entity.
N_NAME, B_TOPNOD, B_BOTNOD are all keys to the Node entity.

APPENDIX (V)

MIMER table definitions and listings.

(1) Description of the 'MED' databank.
(2) Description of all tables (listing of table 'TABLE').
(3) Table definitions and contents.

Databank: MED   File: MED.

Access		Size	
General	User	Allocated	Used
X	X	131	129

Tables:

AIU	AIUUNIT	BRANCH	CABLE	CB	DD	ELEMENT	FS
ISOLATOR	LAND	LINE	LVCIRCT	LVPANEL	NODE	OS	ROUND
SUB	TABLE	TRANSFMR	WIS	WISSUB			

Index Table to all Relational Tables

TABLENAM	INDEX	DESCRIPT
AIU	13	All Insulated Units
AIUUNIT	14	Individual units within AIUs
BRANCH	18	Network Equipment Branch
CABLE	16	Network Cables
CB	7	Circuit Breakers
DD	20	Data Dictionary-Item definitions
ELEMENT	19	Network Branch Element
FS	9	Fuse Switches
ISOLATOR	10	Isolators,Reclosers etc.
LAND	1	MED Land Sites
LINE	15	Network Lines
LVCIRCT	12	Low Voltage Panel Circuits
LVPANEL	11	Low Voltage Panels
NODE	17	Network Equipment Node
OS	8	Oil Switches
ROUND	4	Transformer Rounds
SUB	5	Network Substations
TABLE	21	This table describing Databank
TRANSFMR	6	Transformers
WIS	2	Work Instruction Sheets
WISSUB	3	Substations involved in WISs

21 row(s) printed

Table AIU in databank MED 1983-09-26, 16:57

AIU	1	AIUMAKE	*	C	16
	2	AIUSERN	*	C	16
	3	LMEDNAM		C	32
	4	NNAME		C	20

Table AIUUNIT in databank MED 1983-09-26, 16:57

AIUUNIT	1	AIUMAKE	*	C	16
	2	AIUSERN	*	C	16
	3	AIUUNIT	*	I	2
	4	BTOPSUB		C	32
	5	BTOPNOD		C	20
	6	BBOTSUB		C	32
	7	BBOTNOD		C	20
	8	AIUDLAB		C	30

Table BRANCH in databank MED 1983-09-26, 16:57

BRANCH	1	BTOPSUB	*	C	32
	2	BTOPNOD	*	C	20
	3	BBOTSUB	*	C	32
	4	BBOTNOD	*	C	20

Table CABLE in databank MED 1983-09-26, 16:57

CABLE	1	CNUMBER	*	I	2
	2	BTOPSUB		C	32
	3	BTOPNOD		C	20
	4	BBOTSUB		C	32
	5	BBOTNOD		C	20
	6	ESEQ		I	2

Table CB in databank MED 1983-09-26, 16:58

CB	1	LMEDNAM	*	C	32
	2	NNAME	*	C	20
	3	CBPANEL	*	I	2
	4	CBDESUB		C	32
	5	CBDESND		C	20
	6	CBNSEQ		C	1
	7	ESEQ		I	2
	8	CBDESLB		C	32

Table DD in databank MED 1983-09-26, 16:58

DD	1	DATANAME	*	C	7
	2	DESCRIPT		C	40
	3	EXAMPLE		C	16
	4	FORMAT		C	6
	5	OWNER		C	2

Table ELEMENT in databank MED 1983-09-26, 16:58

ELEMENT	1	BTOPSUB	*	C	32
	2	BTOPNOD	*	C	20
	3	BBOTSUB	*	C	32
	4	BBOTNOD	*	C	20
	5	ESEQ	*	I	2
	6	ETYPE		C	16

Table FS in databank MED 1983-09-26, 16:58

FS	1	LMEDNAM	*	C	32
	2	NNAME	*	C	20
	3	FSPANEL	*	I	2
	4	FSDESUB		C	32
	5	FSDESND		C	20
	6	FSNSEQ		C	1
	7	ESEQ		I	2
	8	FSDESLB		C	32

Table ISOLATOR in databank MED 1983-09-26, 16:58

ISOLATOR	1	INUMBER	*	I	2
	2	BTOPSUB		C	32
	3	BTOPNOD		C	20
	4	BBOTSUB		C	32
	5	BBOTNOD		C	20
	6	ESEQ		I	2

Table LAND in databank MED 1983-09-26, 16:58

LAND	1	LMEDNAM	*	C	32
	2	LVALUE	*	C	16
	3	LSITE		C	16
	4	LBODY		C	16

Table LINE in databank MED 1983-09-26, 16:58

LINE	1	LNUMBER	*	I	2
	2	BTOPSUB		C	32
	3	BTOPNOD		C	20
	4	BBOTSUB		C	32
	5	BBOTNOD		C	20
	6	ESEQ		I	2

Table LVCIRCT in databank MED 1983-09-26, 16:58

LVCIRCT	1	LVNUMBR	*	I	2
	2	LVCTNO	*	I	2
	3	LVCIRCT		C	48

Table LVPANEL in databank MED 1983-09-26, 16:58

LVPANEL	1	LVNUMBR	*	I	2
	2	LMEDNAM		C	32
	3	NNAME		C	20
	4	LVTYPE		C	8
	5	LVDESC		C	20

Table NODE in databank MED 1983-09-26, 16:59

NODE	1	LMEDNAM	*	C	32
	2	NNAME	*	C	20
	3	NTYPE		C	16
	4	NVOLT		F	4

Table OS in databank MED 1983-09-26, 16:59

OS	1	LMEDNAM	*	C	32
	2	NNAME	*	C	20
	3	OSPANEL	*	I	2
	4	OSDESUB		C	32
	5	OSDESND		C	20
	6	OSNSEQ		C	1
	7	ESEQ		I	2
	8	OSDESLB		C	32

Table ROUND in databank MED 1983-09-26, 16:59

ROUND	1	RONUMBR	*	I	2
	2	ROSEQ	*	I	2
	3	LMEDNAM		C	32
	4	TNAME		C	16

Table SUB   in databank MED   1983-09-26, 16:59

SUB	1	LMEDNAM	*	C	32
	2	SBATTRY		C	1
	3	SBATVOL		I	2
	4	SBUILDG		C	8
	5	SCHARGE		C	1
	6	SCOLOUR		C	8
	7	SDATE		C	5
	8	SDOORS		C	8
	9	STYPE		C	12

Table TABLE   in databank MED   1983-09-26, 16:59

TABLE	1	TABLENAM	*	C	8
	2	INDEX		I	2
	3	DESCRIPT		C	32

Table TRANSFMR in databank MED   1983-09-26, 16:59

TRANSFMR	1	LMEDNAM	*	C	32
	2	TNAME	*	C	16
	3	BTOPSUB		C	32
	4	BTOPNOD		C	20
	5	BBOTSUB		C	32
	6	BBOTNOD		C	20
	7	ESEQ		I	2

Table WIS   in databank MED   1983-09-26, 16:59

WIS	1	WISNO	*	I	2
	2	WISDES		C	48

Table WISSUB   in databank MED   1983-09-26, 16:59

WISSUB	1	WISNO	*	I	2
	2	LMEDNAM	*	C	32

All Insulated Units

AIUMAKE NNAME	AIUBERN	LMEDNAM
Isopont AIU	E432	New Brighton Rd No. 111
Isopont AIU	E607	Retreat Rd. E.
Isopont AIU 1	G267	Averill St.
Magnefix AIU	A210	Hills Rd. No. 8
Magnefix AIU	C407	Hills Rd. No. 130
Magnefix AIU	D39	Golf Links Rd. S.
Magnefix AIU 2	H349	Averill St.

7 row(s) printed

Units within AIUs

AIUMAKE	AIUSERN	AIUUNIT	BTOPSUB	BTOPNOD	BBOTSUB	BBOTNOD	AIUDLAB
Isopont	E607	50	Retreat Rd. E.	AIU	Retreat Rd. E.	HV Switchgear	Substation Bus
Isopont	E607	51	Retreat Rd. E.	AIU	Retreat Rd. E.	LV Panel	Transformer

2 row(s) printed

Network Branches

BTOPSUB BBOTSUB	BTOPNOD BBOTNOD
Dallington Dallington	HV Switchgear A HV Switchgear B
Dallington Golf Links Rd. S.	HV Switchgear A HV Switchgear A
Dallington Hills Rd. No. 130	HV Switchgear A HV Switchgear
Dallington New Brighton Rd. No. 111	HV Switchgear A HV Switchgear B
Dallington Retreat Rd. E.	HV Switchgear A HV Switchgear
Dallington Tee Joint	HV Switchgear A 5
Dallington Averill St.	HV Switchgear B HV Switchgear
Dallington Dallington	HV Switchgear B HV Switchgear C
Dallington Dallington	HV Switchgear B LV Panel
Dallington Gayhurst Rd. No. 152	HV Switchgear B HV Switchgear
Dallington Golf Links Rd. S.	HV Switchgear B HV Switchgear B
Dallington Lake Terrace Rd. No. 5	HV Switchgear B HV Switchgear B
Dallington Tee Joint	HV Switchgear B 5
Dallington Dallington	HV Switchgear C HV Switchgear D
Dallington Tee Joint	HV Switchgear C 3
Dallington Tee Joint	HV Switchgear C 6
Dallington Averill St.	HV Switchgear D HV Switchgear
Dallington Dallington	HV Switchgear D HV Switchgear A

Dallington Tee Joint	HV Switchgear D 6
Gayhurst Rd. No. 152 Gayhurst Rd. No. 152	HV Switchgear Link A
Gayhurst Rd. No. 152 Gayhurst Rd. No. 152	HV Switchgear Link D
Retreat Rd. E. Retreat Rd. E.	AIU LV Panel
Retreat Rd. E. Retreat Rd. E.	HV Switchgear AIU
SUPPLY Tee Joint	Dallington A-B 5
SUPPLY Tee Joint	Dallington C-D 6

25 row(s) printed

Network Cables

CNUMBER	BTOPSUB	BBOTSUB	BBOTNOD	BTOPNOD	ESEQ
1	Dallington	Retreat Rd. E.	HV Switchgear	HV Switchgear A	2
2	Dallington	Tee Joint	5	HV Switchgear A	3
3	Dallington	Hills Rd. No. 130	HV Switchgear	HV Switchgear A	2
4	Dallington	Golf Links Rd. S.	HV Switchgear A	HV Switchgear A	2
5	Dallington	New Brighton Rd. No. 111	HV Switchgear B	HV Switchgear A	2
6	Dallington	Averill St.	HV Switchgear	HV Switchgear B	2
7	Dallington	Gayhurst Rd. No. 152	HV Switchgear	HV Switchgear B	2
8	Dallington	Golf Links Rd. S.	HV Switchgear B	HV Switchgear B	2
9	Dallington	Lake Terrace Rd. No. 5	HV Switchgear B	HV Switchgear B	2
10	Dallington	Tee Joint	5	HV Switchgear B	2
11	Dallington	Dallington	LV Panel	HV Switchgear B	2
12	Dallington	Tee Joint	6	HV Switchgear C	2
13	Dallington	Tee Joint	3	HV Switchgear C	2
14	Dallington	Averill St.	HV Switchgear	HV Switchgear D	2
15	Dallington	Tee Joint	6	HV Switchgear D	2
16	SUPPLY	Tee Joint	5	Dallington A-B	1
17	SUPPLY	Tee Joint	5	Dallington A-B	3
18	SUPPLY	Tee Joint	6	Dallington C-D	1

19 SUPPLY		Dallington C-D	
Tee Joint	6		3
20 Retreat Rd. E.		HV Switchgear	
Retreat Rd. E.	AIU		2
21 Retreat Rd. E.		AIU	
Retreat Rd. E.	LV Panel		2
22 Gayhurst Rd. No. 152		HV Switchgear	
Gayhurst Rd. No. 152	Link A		2
23 Gayhurst Rd. No. 152		HV Switchgear	
Gayhurst Rd. No. 152	Link D		2
30 Averill St.		HV Switchgear	
Averill St.	AIU 1		2

24 row(s) printed

Circuit Breakers

LMEDNAM	CBDESUB	CBDESLB	NNAME	CBDESND	CBPANEL	CBNSEQ	ESEQ
Averill St.	Dallington	Dallington Dist. Sub.	HV Switchgear	HV Switchgear B	16	B	3
Averill St.	Averill St.	AIU	HV Switchgear	AIU 1	20	T	1
Averill St.	Dallington	Dallington Dist. Sub.	HV Switchgear	HV Switchgear D	21	B	3
Dallington	Retreat Rd. E.	Retreat Road East	HV Switchgear A	HV Switchgear	1	T	1
Dallington	Tee Joint	Feeder	HV Switchgear A	5	2	T	1
Dallington	Hills Rd. No. 130	Hills Rd. #130	HV Switchgear A	HV Switchgear	3	T	1
Dallington	Golf Links Rd. S.	Golf Links Rd.	HV Switchgear A	HV Switchgear A	4	T	1
Dallington	New Brighton Rd. No. 111	New Brighton Rd. #111	HV Switchgear A	HV Switchgear B	5	T	1
Dallington			HV Switchgear A		6		0
Dallington	Averill St.	Averill Street	HV Switchgear B	HV Switchgear	8	T	1
Dallington	Gayhurst Rd. No. 152	Gayhurst Rd. #152	HV Switchgear B	HV Switchgear	9	T	1
Dallington	Golf Links Rd. S.	Golf Links Rd S unit 33	HV Switchgear B	HV Switchgear B	10	T	1
Dallington	Lake Terrace Rd. No. 5	Lake Terrace Rd.#5	HV Switchgear B	HV Switchgear B	11	T	1
Dallington			HV Switchgear B		12		

Tee Joint Feeder	5	T		1
Dallington Dallington Local/Ripplay	HV Switchgear B LV Panel	T	13	1
Dallington	HV Switchgear C		15	0
Dallington Tee Joint Feeder	HV Switchgear C 6	T	16	1
Dallington	HV Switchgear C		17	0
Dallington	HV Switchgear C		18	0
Dallington Tee Joint Marshland Road Overhead	HV Switchgear C 3	T	19	1
Dallington Averill St. Averill St. Unit 21	HV Switchgear D HV Switchgear	T	21	1
Dallington	HV Switchgear D		22	0
Dallington	HV Switchgear D		23	0
Dallington Tee Joint Feeder	HV Switchgear D 6	T	24	1
Dallington	HV Switchgear D		25	0
Gayhurst Rd. No. 152 Dallington Dallington Dist. Sub	HV Switchgear HV Switchgear B	B	3	3
Golf Links Rd. S. Dallington Dallington Dist. Sub.	HV Switchgear A HV Switchgear A	B	13	3
Golf Links Rd. S. Dallington Dallington Dist Sub.	HV Switchgear B HV Switchgear B	B	33	3
Hills Rd. No. 130 Dallington Dallington Dist. Sub	HV Switchgear HV Switchgear A	B	14	3
Lake Terrace Rd. No. 5 Dallington Dallington Dist Sub.	HV Switchgear B HV Switchgear B	B	3	3

New Brighton Rd. No. 111 Dallington Dallington Dist. Sub	HV Switchgear B HV Switchgear A	 B	10	 3
Retreat Rd. E. Dallington Dallington Dist. Sub.	HV Switchgear HV Switchgear A	 B	10	 3
Retreat Rd. E. Retreat Rd. E. Local AIU	HV Switchgear AIU	 T	13	 1

33 row(s) printed

Circuit Elements

BTOPSUB BBOTSUB ETYPE	BTOPNOD BBOTNOD	ESEQ
Averill St.	HV Switchgear	
Averill St.	AIU 1	1
CB		
Averill St.	HV Switchgear	
Averill St.	AIU 1	2
CABLE		
Dallington	HV Switchgear A	
Dallington	HV Switchgear B	1
BUSBAR		
Dallington	HV Switchgear A	
Golf Links Rd. S.	HV Switchgear A	1
CB		
Dallington	HV Switchgear A	
Golf Links Rd. S.	HV Switchgear A	2
CABLE		
Dallington	HV Switchgear A	
Golf Links Rd. S.	HV Switchgear A	3
CB		
Dallington	HV Switchgear A	
Hills Rd. No. 130	HV Switchgear	1
CB		
Dallington	HV Switchgear A	
Hills Rd. No. 130	HV Switchgear	2
CABLE		
Dallington	HV Switchgear A	
Hills Rd. No. 130	HV Switchgear	3
CB		
Dallington	HV Switchgear A	
New Brighton Rd. No. 111	HV Switchgear B	1
CB		
Dallington	HV Switchgear A	
New Brighton Rd. No. 111	HV Switchgear B	2
CABLE		
Dallington	HV Switchgear A	
New Brighton Rd. No. 111	HV Switchgear B	3
CB		
Dallington	HV Switchgear A	
Retreat Rd. E.	HV Switchgear	1
CB		
Dallington	HV Switchgear A	

Retreat Rd. E. CABLE	HV Switchgear	2
Dallington Retreat Rd. E. CB	HV Switchgear A HV Switchgear	3
Dallington Tee Joint CB	HV Switchgear A 5	1
Dallington Tee Joint CABLE	HV Switchgear A 5	3
Dallington Averill St. CB	HV Switchgear B HV Switchgear	1
Dallington Averill St. CABLE	HV Switchgear B HV Switchgear	2
Dallington Averill St. CB	HV Switchgear B HV Switchgear	3
Dallington Dallington BUSBAR	HV Switchgear B HV Switchgear C	1
Dallington Dallington CB	HV Switchgear B LV Panel	1
Dallington Dallington CABLE	HV Switchgear B LV Panel	2
Dallington Dallington TRANSFMR	HV Switchgear B LV Panel	3
Dallington Gayhurst Rd. No. 152 CB	HV Switchgear B HV Switchgear	1
Dallington Gayhurst Rd. No. 152 CABLE	HV Switchgear B HV Switchgear	2
Dallington Gayhurst Rd. No. 152 CB	HV Switchgear B HV Switchgear	3
Dallington Golf Links Rd. S. CB	HV Switchgear B HV Switchgear B	1
Dallington Golf Links Rd. S. CABLE	HV Switchgear B HV Switchgear B	2
Dallington Golf Links Rd. S. CB	HV Switchgear B HV Switchgear B	3

Dallington Lake Terrace Rd. No. 5 CB	HV Switchgear B HV Switchgear B	1
Dallington Lake Terrace Rd. No. 5 CABLE	HV Switchgear B HV Switchgear B	2
Dallington Lake Terrace Rd. No. 5 CB	HV Switchgear B HV Switchgear B	3
Dallington Tee Joint CB	HV Switchgear B 5	1
Dallington Tee Joint CABLE	HV Switchgear B 5	2
Dallington Dallington BUSBAR	HV Switchgear C HV Switchgear D	1
Dallington Tee Joint CB	HV Switchgear C 3	1
Dallington Tee Joint CABLE	HV Switchgear C 3	2
Dallington Tee Joint THRU JOINT	HV Switchgear C 3	3
Dallington Tee Joint LINE	HV Switchgear C 3	4
Dallington Tee Joint ISOLATOR	HV Switchgear C 3	5
Dallington Tee Joint LINE	HV Switchgear C 3	6
Dallington Tee Joint ISOLATOR	HV Switchgear C 3	7
Dallington Tee Joint LINE	HV Switchgear C 3	8
Dallington Tee Joint CB	HV Switchgear C 6	1
Dallington Tee Joint CABLE	HV Switchgear C 6	2
Dallington	HV Switchgear D	

Averill St. CB	HV Switchgear	1
Dallington Averill St. CABLE	HV Switchgear D HV Switchgear	2
Dallington Averill St. CB	HV Switchgear D HV Switchgear	3
Dallington Dallington BUSBAR	HV Switchgear D HV Switchgear A	1
Dallington Tee Joint CB	HV Switchgear D 6	1
Dallington Tee Joint CABLE	HV Switchgear D 6	2
Gayhurst Rd. No. 152 Gayhurst Rd. No. 152 FS	HV Switchgear Link A	1
Gayhurst Rd. No. 152 Gayhurst Rd. No. 152 CABLE	HV Switchgear Link A	2
Gayhurst Rd. No. 152 Gayhurst Rd. No. 152 OS	HV Switchgear Link D	1
Gayhurst Rd. No. 152 Gayhurst Rd. No. 152 CABLE	HV Switchgear Link D	2
Retreat Rd. E. Retreat Rd. E. AIUUNIT	AIU LV Panel	1
Retreat Rd. E. Retreat Rd. E. CABLE	AIU LV Panel	2
Retreat Rd. E. Retreat Rd. E. TRANSFMR	AIU LV Panel	3
Retreat Rd. E. Retreat Rd. E. CB	HV Switchgear AIU	1
Retreat Rd. E. Retreat Rd. E. CABLE	HV Switchgear AIU	2
Retreat Rd. E. Retreat Rd. E. AIUUNIT	HV Switchgear AIU	3
SUPPLY Tee Joint CABLE	Dallington A-B 5	1

SUPPLY Tee Joint TRANSFMR	Dallington A-B 5	 2
SUPPLY Tee Joint CABLE	Dallington A-B 5	 3
SUPPLY Tee Joint CABLE	Dallington C-D 6	 1
SUPPLY Tee Joint TRANSFMR	Dallington C-D 6	 2
SUPPLY Tee Joint CABLE	Dallington C-D 6	 3

68 row(s) printed

Fuse Switches

LMEDNAM / FSDESUB / FSDESLB	NNAME / FSDESND	FSNSEQ	FSPANEL	ESEQ
Gayhurst Rd. No. 152	HV Switchgear		15	
Gayhurst Rd. No. 152	Link A	T		1
Old Link A				

1 row(s) printed

Isolators, Reclosers, Sectioalizers

INUMBER	BTOPSUB	BTOPNOD	BBOTSUB	BBOTNOD	ESEQ
108	Dallington	HV Switchgear C	Tee Joint	3	5
135	Dallington	HV Switchgear C	Tee Joint	3	7

2 row(s) printed

MED Land

LMEDNAM LBODY	LVALUE	LSITE
 WCC	60712	Construction
 WCC	70123	Barren
Averill St. CCC	67837	Sub.
Dallington CCC	20197	District Sub.
Dallington Ter. CCC	30764	Sub.
Gayhurst Rd. No. 152 CCC	81360	Sub.
Golf Links Rd. S. CCC	10972	Network Sub.
Hills Rd. No. 130 CCC	63372	Sub.
Hills Rd. No. 8 CCC	40753	Sub.
Lake Terrace Rd. No. 5 CCC	99216	Sub.
New Brighton Rd. No. 111 CCC	78692	Sub.
Packe St. CCC	60123	Switchyard
Retreat Rd. E. CCC		Sub.

13 row(s) printed

Network Lines

LNUMBER	BTOPSUB	BTOPNOD	BBOTSUB	BBOTNOD	ESEQ
1	Dallington	HV Switchgear C	Tee Joint	3	4
2	Dallington	HV Switchgear C	Tee Joint	3	6
3	Dallington	HV Switchgear C	Tee Joint	3	8

3 row(s) printed

Low Voltage Panel Circuits

LVNUMBR	LVCTNO	LVCIRCT
1	1	Down Southside Cook St, into the Endeavour
1	2	Southside Bonnybrook,west Thatcher Cres.
2	1	Due E. Main North Rd.
3	1	Se one St.,two St. and so on
3	2	From Forresters to the Hole in the Wall
4	1	Down S. Lake Terrace
5	1	S Main St., W. Richard St.
6	1	Axford Ave, W to Scott Ter.
7	1	S. down Table St. R into Sunshine Dr.
8	1	Down Manchester St. until Worcester St.
8	2	N. along Hackthorne Rd, W down Carmen Ave.
9	1	NE. down Wilshire B.
10	1	To left and along Oxford Ter.

13 row(s) printed

Low Voltage Panels

LVNUMBR	LMEDNAM	NNAME	LVTYPE	LVDESC
1	Averill St.	LV Panel 1	Marble	2 CCT 200A
2	Averill St.	LV Panel 2	Wood	1 CCT 800A
3	Dallington	LV Panel	Steel	2 CCT 300A
4	Dallington Ter.	LV Panel	Marble	1 CCT 300A
5	Gayhurst Rd. No. 152	LV Panel	Marble	1 CCT 300A
6	Golf Links Rd. S.	LV Panel	Wood	1 CCT 800A
7	Hills Rd. No. 130	LV Panel	Marble	1 CCT 300A
8	Hills Rd. No. 8	LV Panel	Marble	2 CCT 800A
9	New Brighton Rd. No. 111	LV Panel	Wood	1 CCT 300A
10	Retreat Rd. E.	LV Panel	Marble	1 CCT 300A

10 row(s) printed

Network Nodes

LMEDNAM	NVOLT	NNAME	NTYPE
Averill St.	1100	AIU 1	AIU
Averill St.	1100	AIU 2	AIU
Averill St.	1100	HV Switchgear	SWITCHGEAR
Averill St.	400	LV Panel 1	LV PANEL
Averill St.	400	LV Panel 2	LV PANEL
Dallington	1100	HV Switchgear A	SWITCHGEAR
Dallington	1100	HV Switchgear B	SWITCHGEAR
Dallington	1100	HV Switchgear C	SWITCHGEAR
Dallington	1100	HV Switchgear D	SWITCHGEAR
Dallington	400	LV Panel	LV PANEL
Dallington	6600	Supply	FEEDER
Dallington Ter.	400	LV Panel	LV PANEL
Gayhurst Rd. No 152	1100	HV Switchgear	SWITCHGEAR
Gayhurst Rd. No 152	1100	Link A	LINK
Gayhurst Rd. No 152	1100	Link D	LINK
Gayhurst Rd. No 152	400	LV Panel	LV PANEL
Golf Links Rd. S.	1100	AIU	AIU
Golf Links Rd. S.	1100	HV Switchgear A	SWITCHGEAR

Golf Links Rd. S.	1100	HV Switchgear B	SWITCHGEAR
Golf Links Rd. S.	400	LV Panel	LV PANEL
Hills Rd. No 130	1100	AIU	AIU
Hills Rd. No 130	1100	LV Panel	SWITCHGEAR
Hills Rd. No 8	1100	AIU	AIU
Hills Rd. No 8	400	LV Panel	LV PANEL
Lake Terrace Rd. No. 5	1100	HV Switchgear A	SWITCHGEAR
Lake Terrace Rd. No. 5	1100	HV Switchgear B	SWITCHGEAR
New Brighton Rd. No. 111	1100	AIU	AIU
New Brighton Rd. No. 111	1100	HV Switchgear A	SWITCHGEAR
New Brighton Rd. No. 111	1100	HV Switchgear B	SWITCHGEAR
New Brighton Rd. No. 111	400	LV Panel	LV PANEL
Retreat Rd. E.	1100	AIU	AIU
Retreat Rd. E.	1100	HV Switchgear	SWITCHGEAR
Retreat Rd. E.	400	LV Panel	LV PANEL
Tee Joint	1100	1	TEE JOINT
Tee Joint	1100	2	TEE JOINT
Tee Joint	1100	3	TEE JOINT
Tee Joint	1100	4	TEE JOINT
Tee Joint	1100	5	TEE JOINT
Tee Joint	1100	6	TEE JOINT

39 row(s) printed

Oil Switches

LMEDNAM OSDESUB OSDESLB	NNAME OSDESND	OSNSEQ	OSPANEL	ESEQ
Gayhurst Rd. No. 152 Gayhurst Rd. No. 152 Old Link D	HV Switchgear Link D	T	17	1

1 row(s) printed

Transformer Rounds

RONUMBR	ROSEQ	LMEDNAM	TNAME
1	1	Averill St.	1
1	2	Averill St.	2
1	3	New Brighton Rd. No. 111	
2	1	Dallington	Local
2	2	Dallington	T1
2	3	Dallington	T2
2	4	Dallington Ter.	
3	1	Gayhurst Rd. No. 152	
3	2	Golf Links Rd. S.	
3	3	Hills Rd. No. 130	
3	4	Hills Rd. No. 8	
3	5	Retreat Rd. E.	

12 row(s) printed

Substations

LMEDNAM SDATE SDOORS STYPE	SBATTRY	SBATVOL	SBUILDG	SCHARGE	SCOLOUR
Averill St. 2/64 Al Outdoor	Y	12	B2067	Y	Yellow
Dallington 3/60 Steel District	Y	12	B1067	Y	Brown
Dallington Ter. 7/47 Timber Building	N	6	B2067	N	Green
Gayhurst Rd. No. 152 7/49 Steel Pole	Y	6	B961	Y	Brown
Golf Links Rd. S. 1/59 Steel Pole	N	6	B6431	N	Hot Red
Hills Rd. No. 130 11/73 Timber Low Kiosk	N	12	B032	N	Green
Hills Rd. No. 8 6/55 Timber Low Kiosk	N	12	B7361	N	Green
Lake Terrace Rd. No. 5 11/49 Al Outdoor	Y	6	B1249	N	Brown
New Brighton Rd. No. 111 8/56 Steel Building	Y	12	B0073	Y	Brown
Retreat Rd. E. 12/43 Timber Hi Kiosk	N	12	B63	N	Green

10 row(s) printed

Network Transformers

LMEDNAM BTOPSUB BBOTSUB	TNAME BTOPNOD BBOTNOD	ESEQ
Averill St. Averill St. Averill St.	1 HV Switchgear LV Panel 1	3
Averill St. Averill St. Averill St.	2 HV Switchgear LV Panel 2	3
Dallington Dallington Dallington	Local HV Switchgear LV Panel	3
Dallington Dallington Tee Joint	T1 Supply 5	2
Dallington Dallington Tee Joint	T2 Supply 6	2
Dallington Ter. Gayhurst Rd. No. 152 Dallington Ter.	 Link D LV Panel	3
Gayhurst Rd. No. 152 Gayhurst Rd. No. 152 Gayhurst Rd. No. 152	 Link A LV Panel	3
Golf Links Rd. S. Golf Links Rd. S. Golf Links Rd. S.	 HV Switchgear LV Panel	3
Hills Rd. No. 130 Hills Rd. No. 130 Hills Rd. No. 130	 AIU LV Panel	3
Hills Rd. No. 8 Hills Rd. No. 8 Hills Rd. No. 8	 AIU LV Panel	3
New Brighton Rd. No. 111 New Brighton Rd. No. 111 New Brighton Rd. No. 111	 HV Switchgear LV Panel	3
Retreat Rd. E. Retreat Rd. E. Retreat Rd. E.	 HV Switchgear LV Panel	3

12 row(s) printed

Work Instruction Sheets

WISNO	WISDES
693	Installation of new overhead line
1193	Replacement of cable joint
1932	Maintenance of Retreat Rd. E.
2103	Urgent work, Underground LV reticulation
2104	Tee jointing U/G cable between Hills Rd. Nos 8,1

5 row(s) printed

Which WISs Concern which Substations

WISNO	LMEDNAM
693	Averill St.
693	Gayhurst Rd. No. 152
693	Hills Rd. No. 130
693	Hills Rd. No. 8
693	New Brighton Rd. No. 111
1193	Dallington Ter.
1193	Hills Rd. No. 130.
1193	Lake Terrace Rd. No. 5
1932	Golf Links Rd. S.
1932	Hills Rd. No. 130
1932	Hills Rd. No. 8
1932	Retreat Rd. E.
2103	Dallington
2103	Dallington Ter.
2104	Dallington
2104	Dallington Ter.
2104	Hills Rd. No. 130
2104	Hills Rd. No. 8

18 row(s) printed

APPENDIX (VI)

MIMER procedures library -Query 'program'.

```
A          10 +COMMENT                                                   ;
A          20 +COMMENT  MED POWER SUPPLY NETWORK     August 1983         ;
A          30 +COMMENT  ------------------------                         ;
A          40 +COMMENT  A Demonstration Database     Paul J. Commons     ;
A          50 +COMMENT  ------------------------                         ;
A          60 +COMMENT                                                   ;
A          70 +COMMENT  Implementation of main Information Queries       ;
A          80 +COMMENT   Via MIMER/QL procedures. This procedure          ;
A          90 +COMMENT   library provides a easy-to-use interface         ;
A         100 +COMMENT   between the database and its users. Levels       ;
A         110 +COMMENT   of menus inform users of inquiry options.        ;
A         120 +COMMENT   Informative prompts guides the user entry        ;
A         130 +COMMENT   of key data items. Relational table and          ;
A         140 +COMMENT   data item definitions are further helpful        ;
A         150 +COMMENT   aids for database users.                         ;
A         160 +COMMENT                                                   ;
A         170 +COMMENT  The top level menu for this query library        ;
A         180 +COMMENT   is contained within procedure MENU.  All         ;
A         190 +COMMENT   other menus are reached from this procedure;
A         200 +COMMENT   The user runs these query procedures via         ;
A         210 +COMMENT   the MIMER-QL command EXEC QUERY(MENU);.  The;
A         220 +COMMENT   top level menu is initially displayed.           ;
AIU       100 +WRITE    '  ';
AIU       110 +WRITE    'AIU Menu';
AIU       120 +WRITE    '  ';
AIU       130 +CASE     AIU1      'Retrieval by AIU make and serial no.';
AIU       140 +CASE     AIU2      'Retrieval by Substation'              ;
AIU       145 +CASE     AIU3      'Retrieval of all units within an AIU';
AIU       150 +CASE     STOP      'Exit'                                 ;
AIU1       10 GET    AIU.* WHERE AIU.AIUMAKE BW +PROMPT 'Enter make' AND
AIU1       20            AIU.AIUSERN BW +PROMPT 'Enter Serial no.';
AIU2       10 GET    AIU.AIUMAKE, AIU.AIUSERN, AIU.NNAME WHERE
AIU2       20         AIU.LMEDNAM BW +PROMPT 'Enter Sub. name';
AIU3       10 GET     AIUUNIT.* WHERE AIUUNIT.AIUMAKE BW
AIU3       20           +PROMPT 'Enter make' AND AIUUNIT.AIUSERN BW
AIU3       30           +PROMPT 'Enter Serial no.';
BRANCH     10 +COMMENT                                                        ;
BRANCH     20 +COMMENT  Lists all branches from a Node within a Substation;
BRANCH     30 +COMMENT                                                        ;
BRANCH     40 +LET      &SN=+PROMPT 'Enter Substation name';
BRANCH     50 +LET      &NN=+PROMPT 'Enter Node name';
BRANCH     60 GET     BRANCH.* WHERE BRANCH.BTOPSUB BW &SN
BRANCH     70          AND BRANCH.BTOPNOD BW &NN;
BRANCH     80 GET     BRANCH.* WHERE BRANCH.BBOTSUB BW &SN
BRANCH     90          AND BRANCH.BBOTNOD BW &NN;
CABLE      10 GET  CABLE.* WHERE CABLE.CNUMBER EQ +PROMPT 'Enter Cable Number';
CB        100 +WRITE    '  ';
CB        110 +WRITE    'Circuit Breaker Menu';
CB        120 +WRITE    '  ';
CB        130 +CASE     CB1       'Retrieval by Sub., Node and panel no.';
CB        140 +CASE     CB2       'Retrieval by Substation'              ;
CB        150 +CASE     STOP      'Exit'                                 ;
```

```
CB1        10 GET     CB.* WHERE CB.LMEDNAM BW +PROMPT 'Enter Sub. name'
CB1        20                 AND CB.NNAME BW +PROMPT 'Enter Node name'
CB1        30                 AND CB.CBPANEL EQ +PROMPT 'Enter Panel no.';
CB2        10 GET     CB.* WHERE CB.LMEDNAM BW +PROMPT 'Enter Sub. name';
DESDATA    10 GET     DD.* WHERE DD.DATANAME BW +PROMPT 'Enter data item name';
DESTABLE   10 +LET     &TN=+PROMPT 'Enter Table name';
DESTABLE   20 GET      TABLE.* WHERE TABLE.TABLENAM BW &TN;
DESTABLE   30 DESCRIBE TABLE &TN;
ELEMENT    10 +COMMENT                                  ;
ELEMENT    20 +COMMENT  Lists all Elements in a Branch;
ELEMENT    30 +COMMENT                                  ;
ELEMENT    40 GET    ELEMENT.ESEQ,ELEMENT.ETYPE WHERE
ELEMENT    50         ELEMENT.BTOPSUB BW +PROMPT 'Enter Top Sequence Sub.' AND
ELEMENT    60         ELEMENT.BTOPNOD BW +PROMPT 'Enter Top Node.' AND
ELEMENT    70         ELEMENT.BBOTSUB BW +PROMPT 'Enter Bottom Sub.' AND
ELEMENT    80         ELEMENT.BBOTNOD BW +PROMPT 'Enter Bottom Node.';
FS         10 +WRITE     ' ';
FS         20 +WRITE     'Fuse Switch Menu';
FS         30 +WRITE     ' ';
FS         40 +CASE      FS1       'Retrieval by Sub,Node and panel no.';
FS         50 +CASE      FS2       'Retrieval by Substation'          ;
FS         60 +CASE      STOP      'Exit'                             ;
FS1        10 GET     FS.* WHERE FS.LMEDNAM BW +PROMPT 'Enter Sub. name'
FS1        20                 AND FS.NNAME BW +PROMPT 'Enter Node name'
FS1        30                 AND FS.FSPANEL EQ +PROMPT 'Enter Panel no.';
FS2        10 GET     FS.* WHERE FS.LMEDNAM BW +PROMPT 'Enter Sub. name';
INFORM     20 +COMMENT                                         ;
INFORM     30 +COMMENT  Simple Information Retrieval Queries;
INFORM     40 +COMMENT                                         ;
INFORM     50 +WRITE     ' ';
INFORM     60 +WRITE     'Equipment Menu';
INFORM     70 +WRITE     ' ';
INFORM     80 +CASE      AIU       'All Insulated Units'     ;
INFORM     90 +CASE      LINE      'Lines'                   ;
INFORM    100 +CASE      CABLE     'Cables'                  ;
INFORM    110 +CASE      CB        'Circuit Breakers'        ;
INFORM    120 +CASE      FS        'Fuse Switches'           ;
INFORM    130 +CASE      OS        'Oil Switches'            ;
INFORM    140 +CASE      ISOLATOR  'Isolators'               ;
INFORM    150 +CASE      LAND      'Land'                    ;
INFORM    160 +CASE      LVPANEL   'Low Voltage Panels'      ;
INFORM    170 +CASE      SUB       'Substations'             ;
INFORM    180 +CASE      WIS       'Work Instruction Sheets' ;
INFORM    190 +CASE      STOP      'Exit'                    ;
ISOLATOR   10 GET        ISOLATOR.* WHERE ISOLATOR.INUMBER EQ
ISOLATOR   20              +PROMPT 'Enter Isolator no.';
LAND       10 GET   LAND.* WHERE LAND.LMEDNAM BW +PROMPT 'Enter MED land name';
LINE       10 GET       LINE.* WHERE LINE.LNUMBER EQ +PROMPT 'Enter line no.';
LVPANEL    10 +WRITE     ' ';
LVPANEL    20 +WRITE     'Low Voltage Panel Menu';
LVPANEL    30 +WRITE     ' ';
LVPANEL    40 +CASE      LVPANEL1 'Retrieval by LV panel no.'          ;
LVPANEL    50 +CASE      LVPANEL2 'Retrieval by Substation'            ;
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LVPANEL     60 +CASE       LVPANEL3 'Retrieval of LV circuits within panel';
LVPANEL     70 +CASE       STOP     'Exit'                                  ;
LVPANEL1    10 GET        LVPANEL.* WHERE LVPANEL.LVNUMBR EQ
LVPANEL1    20              +PROMPT 'Enter LV Panel no.';
LVPANEL2    10 GET      LVPANEL.* WHERE LVPANEL.LMEDNAM BW
LVPANEL2    20            +PROMPT 'Enter Sub. name';
LVPANEL3    10 GET       LVCIRCT.LVCTNO,LVCIRCT.LVCIRCT WHERE LVCIRCT.LVNUMBR EQ
LVPANEL3    20             +PROMPT 'Enter LV Panel no.';
MENU        10 +COMMENT     -----------------------------------------------;
MENU        20 +COMMENT     -                                             -;
MENU        30 +COMMENT     -           START,TOP-LEVEL MENU              -;
MENU        40 +COMMENT     -                                             -;
MENU        50 +COMMENT     -----------------------------------------------;
MENU        60 +COMMENT     Top level procedure entered by user upon start of;
MENU        70 +COMMENT      query session.                                ;
MENU        80 +WRITE      '    ';
MENU        90 +WRITE      'MED Network Database';
MENU       100 +WRITE      '--------------------';
MENU       110 +WRITE      '    ';
MENU       120 +WRITE      'General Menu';
MENU       130 +WRITE      '------------';
MENU       140 +WRITE      '    ';
MENU       150 +CASE        SETUP    'Include MED Database to interrogate';
MENU       160 +CASE        INFORM   'Simple Information Retrieval Menu' ;
MENU       170 +CASE        NETWORK  'Network Configuration Menu       ' ;
MENU       180 +CASE        RETRIEVE 'Retrieval of any column,any table' ;
MENU       190 +CASE        PRINT    'Print table                      ' ;
MENU       200 +CASE        DESTABLE 'Describe Relational Table        ' ;
MENU       210 +CASE        DESDATA  'Give data item definition        ' ;
MENU       220 +CASE        STOP     'Stop                             ' ;
NETWORK     10 +COMMENT                                ;
NETWORK     20 +COMMENT  Network configuration Queries ;
NETWORK     30 +COMMENT                                ;
NETWORK     40 +WRITE      '   ';
NETWORK     50 +WRITE      'Network Menu';
NETWORK     60 +WRITE      '   ';
NETWORK     70 +CASE       NODE     'List all Nodes within a given Substation'
NETWORK     80 +CASE       SUBNOD   'List all Branches from a given Substation'
NETWORK     90 +CASE       BRANCH   'List all Branches from a given Substation Node'
NETWORK    100 +CASE       ELEMENT  'List all Elements in a given branch'
NETWORK    110 +CASE       STOP     'Exit'
NODE        10 +COMMENT                                          ;
NODE        20 +COMMENT  Lists all Nodes withing a given Substation;
NODE        30 +COMMENT                                          ;
NODE        40 GET      NODE.NNAME,NODE.NTYPE,NODE.NVOLT WHERE
NODE        50            NODE.LMEDNAM BW +PROMPT 'Enter Substation Name';
OS          10 +WRITE      '   ';
OS          20 +WRITE      'Oil Switch Menu';
OS          30 +WRITE      '   ';
OS          40 +CASE       OS1     'Retrieval by Sub,Node and panel no.';
OS          50 +CASE       OS2     'Retrieval by Substation'            ;
OS          60 +CASE       STOP    'Exit'                               ;
OS1         10 GET      OS.* WHERE OS.LMEDNAM BW +PROMPT 'Enter Sub. name'
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OS1        20               AND OS.NNAME BW +PROMPT 'Enter Node name'
OS1        30               AND OS.OSPANEL EQ +PROMPT 'Enter Panel no.';
OS2        10 GET      OS.* WHERE OS.LMEDNAM BW +PROMPT 'Enter Sub. name';
PRINT      10 PRINT       +PROMPT 'Enter Relational Table name'
PRINT      20              +PROMPT 'Enter Table Title';
RETRIEVE   10 +LET &TN=+PROMPT 'Enter table name';
RETRIEVE   20 +LET &CN=+PROMPT 'Enter column name';
RETRIEVE   30 +LET &CV=+PROMPT 'Enter comparison value';
RETRIEVE   40 +LET &RO=+PROMPT 'Enter Relational Operator';
RETRIEVE   50 GET &TN.* WHERE &TN.&CN &RO &CV;
SETUP      10 +WRITE   '   ';
SETUP      20 +WRITE  'Database Description-';
SETUP      30 INCLUDE:X MED;
SETUP      40 DESCRIBE DATABANK MED;
SETUP      50 SET ILEN='4';
SETUP      60 SET FLEN='6';
SETUP      70 SET LC='60';
SETUP      80 +WRITE  'Database Included and available for use';
STOP      100 +STOP;
SUB        10 GET       SUB.* WHERE SUB.LMEDNAM BW +PROMPT 'Enter Sub. name';
SUBNOD     10 +COMMENT                                   ;
SUBNOD     20 +COMMENT  Lists all branches from a substation;
SUBNOD     30 +COMMENT                                   ;
SUBNOD     40 +LET        &SN=+PROMPT 'Enter Substation name';
SUBNOD     50 GET       BRANCH.* WHERE BRANCH.BTOPSUB BW &SN OR
SUBNOD     60            BRANCH.BBOTSUB BW &SN;
TRANSFMR  100 +WRITE      '  '                         ;
TRANSFMR  110 +WRITE      'Network Transformers menu';
TRANSFMR  120 +WRITE      '  '                         ;
TRANSFMR  130 +CASE       TRANS1    'Retrieval by Substation and transformer name';
TRANSFMR  140 +CASE       TRANS2    'Retrieval by Substation only'                ;
TRANSFMR  150 +CASE       TRANS3    'Round list'                                  ;
TRANSFMR  160 +CASE       STOP      'Exit'                                        ;
TRANS1    100 GET         TRANSFMR.* WHERE TRANSFMR.LMEDNAM BW
TRANS1    110              +PROMPT 'Enter Substation name' AND TRANSFMR.TNAME BW
TRANS1    120              +PROMPT 'Enter Transformer name';
TRANS2    130 GET         TRANSFMR.* WHERE TRANSFMR.LMEDNAM BW
TRANS2    140              +PROMPT 'Enter Substation name';
TRANS3    150 GET         ROUND.RONUMBR,ROUND.ROSEQ,TRANSFMR.* WHERE ROUND.RONUMBR
TRANS3    160              EQ +PROMPT 'Enter round no.  AND ROUND.LMEDNAM EQ
TRANS3    170              TRANSFMR.LMEDNAM AND ROUND.TNAME EQ TRANSFMR.TNAME;
WIS        10 +WRITE      '  ';
WIS        20 +WRITE      'Work Instruction Sheet Menu';
WIS        30 +WRITE      '  ';
WIS        40 +CASE       WIS1      'Individual WIS details'                  ;
WIS        50 +CASE       WIS2      'Which Substations are involved in a WIS'  ;
WIS        60 +CASE       WIS3      'Which WISs concern a particular Substation';
WIS        70 +CASE       STOP      'Exit'                                    ;
WIS1       10 GET      WIS.* WHERE WIS.WISNO EQ +PROMPT 'Enter WIS no.';
WIS2       10 GET       WISSUB.LMEDNAM WHERE WISSUB.WISNO EQ
WIS2       20             +PROMPT 'Enter WIS no.';
WIS3       10 GET        WISSUB.WISNO WHERE WISSUB.LMEDNAM BW
WIS3       20              +PROMPT 'Enter Substation name';
```